Time and Space as Narrative in Computer Games

Lucas A. Hansen

Aalborg University Copenhagen
Dept. of Medialogy

May 4th, 2008

Index

List of Figures

Preface

On Quotations

Quotations will appear in double quotes and with italic fonts, which is not to be confused with the reference to games. Immediately following the quotation, is a source reference to the author. As an example "*Someone may have said something significant towards the goals of this thesis*"[source]. A particularly long quotation would be placed in a separate paragraph, contrary to short quotations which will appear in line.

The bibliography in appendix A, further details referenced sources.

On Notations of Games

This report presupposes computer games as authentic sources for observational purposes. References to games will be in single quotes with italic text. Where possible, games will be quoted for director/game designer and subsequently company and year of distribution. This report does however; acknowledge that such may not be possible in all cases and that some games are mainly team efforts. In these cases the company alone will be credited. As such: '*The Game'*(Game developers, year).

The logography in Appendix B, lists referenced games.

Chapter Overview

To clarify the reading, each of the following chapters opens with an introduction to the specific points visited in therein, and likewise closes with a sub-conclusion, where possible. The structure of the report as a whole will be ordered as follows:

- **Chapter 1 Introduction**, uncovers the motivation for the thesis as well as the initial problem formulation.
- **Chapter 2 Related Work**, uncovers material similar to that which is presented in the following report. This research is included both because it supports the later analysis, but also because it ensures that the thesis strives to remain state of the art.
- **Chapter 3 Pre-analysis**, opens into the founding areas of research, which will serve to refine the problem formulation and provide a knowledge base for expanded research.
- **Chapter 4 Final Problem Formulation**, refines the problem formulation after the knowledge gained through the pre-analysis. This chapter also includes an initial hypothesis that motivates the further research and proposes an answer to final problem formulation.
- **Chapter 5 Analysis**, details the major areas of research that has been done, to answer the problem formulation. The analysis is finalized by the statement of three hypotheses which will address the final problem formulation.
- **Chapter 6 The GRID Model**, refines the lessons learned during the analysis and organizes this knowledge according to the stated hypotheses into an analytical model labeled GRID.
- **Chapter 7 Test Method,** describe the necessary tests that will validate the theories summed up in the GRID model.
- **Chapter 8 Technical Specification**, details the implementation requirements necessary to adequately test the knowledge base of the GRID model.
- **Chapter 9 Design Specification**, specification provides a story-board for implanting the GRID model into a prototype game environment.
- **Chapter 10 Implementation**, details the process and lessons learned during the implementation of the prototype. This includes the first, test which is a proof of concept on the finished implementation.

- **Chapter 11 Test**, details the procedure, presents and discusses the findings of the second quantitative test that addresses the hypothesis. This chapter also details the third qualitative test which aims to verify the quantitative empirical findings.
- **Chapter 12 Conclusion**, discusses the empirical data surmised from the test and proposes future work and implementation connected to the GRID model.

While the following appendices includes further information, not necessary to the reading of this thesis, Appendix C: Keywords, provides a list of the concepts there will be used through the thesis. This is included to increase readability.

The Definite Article

Throughout this report, references to a generalized subject will be in the pronoun form of 'him', 'his' or 'he', which is of little consequence to the subject matter. The report does however visit upon a total of three different, although similar abstractions of the human subject. The 'Viewer' will be introduced in chapter n.n. as a part of film theory. The 'Citizen' is described by the workings of Kevin Lynch and will be detailed in chapter n.n. Finally, the 'Player' is examined as a part of this thesis and will be described as the product of the discussion, chapter n.

During the testing chapter there will be made references to the test population as 'Test Subjects' or simply; 'Subjects'. These are of cause not generalizations, but will serve to make such.

Terminology of 'level'

The word 'level' is used in several respects, from being a synonym of 'degree', describing the floor number of a building and even Czech Computer game magazine. The usage of the word 'Level' in the following report will refer to the spatial domain of computer games wherein the action takes place.

As with the definite article above, levels can be called many things, depending on the point of view from which it is analyzed. Emphasis on spatiality is favored by authors such as Ryan and Murrary, as their work is not specifically minded towards games, and also aims at Virtual Reality implementations. Due to the close nature of these spatial constructs and levels, there will be made no distinction towards the terminology.

Canon within the Computer Games Industry

One problem with the inclusion of empirical data based on observations from computer games is the lack of canon in digital entertainment industry, compared to Film and Literature. As such, empirical observations that are included will be taken from mainstream and 'popular games'. Games, which have won awards, will be chosen before others.

Recognitions

The author would like to extend his thanks to those who have indirectly helped to complete this thesis; Henrik Bjørkå for good will and collaboration on the prototype development, and Henrik Schønau Fog, for providing in-depth critical feedback, even when he was pressed for time himself.

The author would additionally like to extend his recognition to the work of supervisors Rolf Nordahl and Lars Reng, who have worked hard, both as supervisors in this thesis, but also as representatives of the medialogy study.

Foreword

The emergence of computer game studies is still considered a new one, like the medium itself that is often referred to as 'young'. For the last decade or so, game theorists labeling themselves 'Ludologists' and literary scholars, dubbed Narratologists, have argued about the medium the scientific approach to the media. In this debate, both camps each have their outstanding issues, which it would be beneficial to approach before further study of the medium begins. This can be considered a pre-emptive act, to avoid classifying the following thesis in one of the two categories.

Firstly Ludologists provide a keen understanding of play, and how they describe the sensation of flow. This concept was originally identified by psychologist Mihaly Csikszentmihalyi (1), as the sensation of 'being in the zone' when challenges presented by the game and the skills of the players converge (2) (3). Ludologists aim to explain the experience and functionality of games, definitely bears the right to claim their own field of research. But in rejecting other schools of science's influence on the chosen medium, Ludologists often end up with the aspiration of creating abstract puzzles like '*Tetris'* [1985, Alexey Pajitnov].

Narratologists on the other hand, approach games with the motivatoin of recreating an era of great literary works. From the medium of film theory and literature sciences they bring a sharp understanding of fiction and how the reader experiences the narratives. These are fundamental points in a medium where the player, User, Interactor or simply Reader is empowered to influence the narrative, like never before. And this is also where the Narratologist most often perceive coherency threatened by the chaotic interactions of the user, or evaluate that the user cannot stay immersed in the game if he is forced to interact with it as well. They reconcile such dilemmas by describing artificial intelligence authors, drama managers or similar notions (4) (5). Who is going to code these human-like AI's, remains an interesting question.

So are the games of the future going to rest on act-and-challenge based puzzles that will take you away to a different space/time where you forget about the physical. Or are games going to tell you stories so vividly perfect in such boundless imaginative worlds that you will be carried away from this reality? The point may be over-exaggerated, but it is quite clear, that both studies have approached the medium with their best intentions for it.

The following report is going to be positioned in the middle of these two camps. Both texts from Ludologist Jesper Juul, and Narratologist Marie-Laure Ryan is going to be referenced. The Ludology/Narratology debate has opted to devided researchers, and a counter reaction is indicated by the works of researchers like Henry Jenkins and Ernest Adams. These researchers propose the application of theories from both camps accepting the validity of each scientific discipline and appreciating their different points of view.

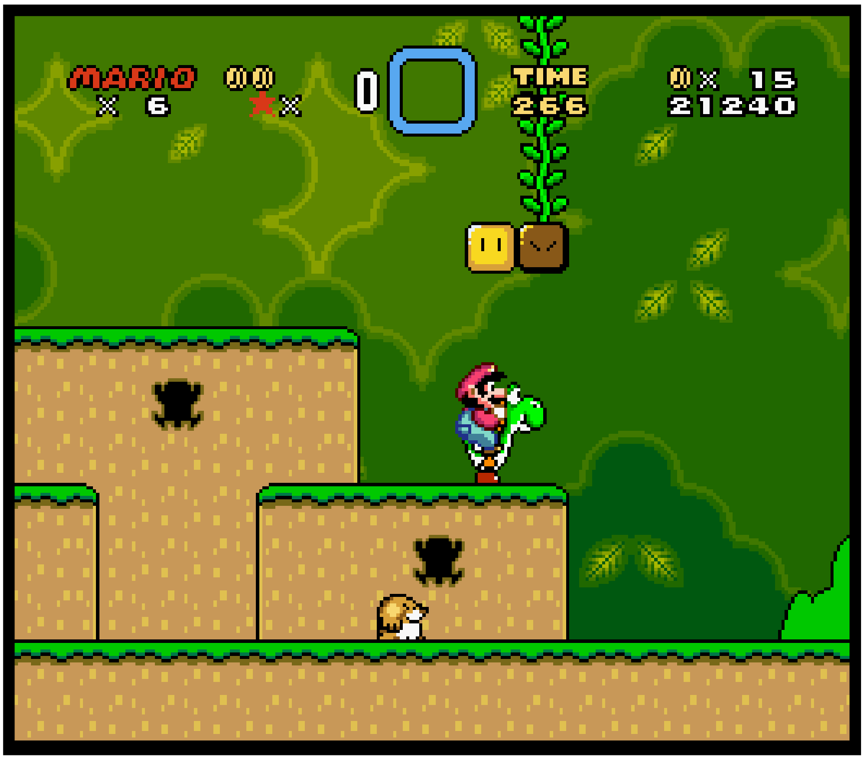


Illustration 1: Super Mario World

1 Introduction

What is level design if not the natural extension of a metaphor that has been with us in our earliest stories? Homers Odyssey is about space the same way Thelma and Louise [Ridley Scott, 1991] is about space, not only as an explorative exertion, but perhaps as much a metaphor for the internal journey of the main characters. In computer games, the nature of space changes into levels and that raises questions towards what makes a good level design.

1.1.1 Motivation

During previous prototype development (6), notably during the 8th semester, in which the author has been involved, the process of level design has reoccurred as fundamental step in the formation of computer games; a properly designed level allows both for the intended action of the game to take place while it encourages the game to move forward without causing unwanted confusion. Designing a good level can therefore "make, or break" the experience for the player.

The human component in the understanding of "The Player" is therefore a central subject in the motivation of this thesis. Uncovering principles of how the player perceives and evaluates the level could provide beneficial information to optimizing the level design process.

Henry Jenkins underlines this motivation in his article "Game Design as Narrative Architecture" (7), when dealing with the Ludology versus Narratolgy debate (as mentioned in the foreword); whether or not the medium of computer games are susceptible to lessons already learned from non-interactive forms of narrative, like theatre, books and cinema. He points out that computer games requires a new formula for analysis that is tailored for specifically for the interactive media. Among the areas that are opened to re-examination through this presupposition, is the construction of levels and the players experience thereof. Through this report, it is the aim to develop an understanding of 'level design' that emphasizes the dramatic structure of the games narrative while sustaining the emphasis on the player.

1.1.2 Observation on the industry

The ambition of this report extends to the roles and responsibilities of game designers and level designers already in the industry. In the introduction of "Level Design for Games – creating compelling game experiences" (8) Phil Co describes the multiple areas in which level designers have to address, from communication with the art department, to the core developers engaged with the coding. Regarding the relationship with the Game Designer, he writes:

"*Level Designers work closely with the game designers---the people responsible for the game's difficulty and balance---to fill the levels with challenges while insuring that the players feel a sense of progression and accomplishment*" (8 s. Introduction x).

The initial problem formulation engages in a direction of research which will increase the degree of storytelling done during the development of the level. As such, a slight redistribution should occur as the level designer becomes a narrative attuned author and the game designer becomes better suited to direct the overall story. This is not to be misunderstood as an attempted overthrowing of the development pipeline, but an acknowledgement that the narrative of most games, plays out in both an overall scheme through cut-scenes, as well as while the player proceeds through the level. Proper understanding of this can help create better games.

1.2 Initial Problem Formulation

"How can understanding of space and time in interactive and non-interactive media, help design better computer games for the player?"

1.2.1 Sub problems

Firstly, if any attempt to explain the human component in computer-games as the player is to be made, model for understanding this notion must be applied. This thesis recognizes the research attributed to the concept of immersion by noteworthy authors (4) (5) (9), but chooses instead to take a constructivist cognitive psychological approach due to its interconnectivity with story comprehension and the Viewer of David Bordwell's neo-formalistic film theory. This raises the first point for the pre-analysis.

The ability to navigate in the games, illustrates one of the distinct differences between non-interactive media and interactive media. More in games than any other media is the human participant is being represented in the fictitious world and thereby given a spatial existence in the media. This freedom to control his own movement is commonly in the form of an avatar, but other games manifests the player via the camera, which he is free to control himself. Unlike non-interactive media, such as books and film, the player is no longer bound to the point of view in which the director frames him. In this way, the player is not subject to the dramatic suspense connected issues of timing.

This raises the following questions:

- How are issues of timing different in computer games from non-interactive narratives?
- In which ways are time used to create suspense in non-interactive narratives?
- How is space observed outside interactive non-interactive narratives?

The pre-analysis will investigate these topics in order to form a final problem formulation.

2 Related Work

To provide an overview this chapter of the report will first approach similar projects in order to approach a SOTA (state of the art) output.

2.1 Level Designer literature

Several books have been published on the spatial aspect of game design. Unfavorably for this report is the practicalities often tied to the job of level design. In the pipeline of game development, the Level Designer is situated between the game developer, the game programmers and the arts department, which affords the job the notion of “putting it all together” and “making it work”. In part, an argument is posed by this report, that the spatial design is fundamental to the game experience and that well crafted worlds expand the overall enjoyment of the game as detailed in above in chapter 1.

2.2 The Game Ontology Project

Reminiscent of narratologists formalistic approach to storytelling is The Game Ontology Project (10) (short: GOP). By establishing a series of categorizations and providing a detailed description on their breath and interrelationship the project delivers a toolbox for understanding and analyzing computer games. The GOP divides game elements and the spatial properties of games differently. As for game elements, this can be considered the objects that, together becomes the gameplay. The classifications include Interface, Rules, Goals, Entities and Entity Manipulations. Where needed later, these classes will be further explored.

Spatial properties of games are further divided into the areas of representation and segmentation. As representation, the focus is how the game world (understood as the entire available space in any of the later established level structures) becomes a visualization of the gameplay, as shown in Figure 1.

Closest to the computation of the game is the gameplay, maintaining and executing the rules of the game. Above that follows the visualization through the level or game world. The topmost layer is the representation which has to do with the point of view provided to the player, whether he perceives the world through a first person view, third person or otherwise. The representation of the game must therefore successfully convey its two consisting elements.

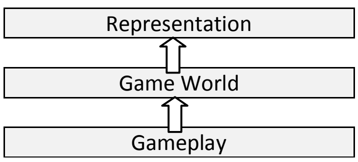


Figure 1: Levels of Spatiality in Games

Space also exists over time in the GOP understanding; this is how ‘Segmentation’ is defined. *Game space* is divided into *Levels*, *Waves* and *Checkpoints*.

- The *level* represents a discreet unit of game space wherein the player, through his avatar is able to act.
- The *Wave* is not clearly defined, but it can be reasonably deducted that the notion represents a temporally triggered change to the game play. Either by a new oncoming wave of enemies or, abstractly, a change in the environment that forces the player to reevaluate his tactics.

- *Checkpoints* are finally the locations which the player must traverse before reaching the end of the level. The fundamental difference between the wave and the checkpoint is therefore the changes that game affects on the game world, and the changes that the player affects.

In its analysis, The Game Ontology project provides a very valid approach to understanding game design from the point of developers and analysts.

2.3 Sub-Conclusion

No actual research has been uncovered which deals primarily with space as an equivalent of narrative time. There can be several reasons for this, the most likely of which is the academic attention assigned either to issues of gameplay or code specific areas, here level design lies in the middle.

This is also a very evident fact, when reevaluating how the level designer has been described as being communicating with all departments. The role of the level designer is thus, the jack of all trades, and master of none.

3 Pre-Analysis

As mentioned in chapter Introduction, the approach to the initial problem formulation forms the basis for a very cross disciplinary report. This will especially be visible in the following chapter as it will seeming leap far between the various topics.

- The report will first provide a description of cognitive psychology that provides basic understanding for several subsequent topics, and eventually builds a foundation for the discussion chapter.
- Then this chapter visits the argumentation for time being different between games and film, which is a primary motivation for the project.
- This section will touch upon non-interactive narratives, for an understanding of the usage of time in the non-interactive medium as an important tool for suspense
- Finally the pre-analysis will close with an investigation popular theories of spatial cognition to build an understanding of principles navigation.

Because there is no linear connection between the mentioned sections, driving this chapter forward, it will not close with a sub-conclusion.

3.1 Cognitive Psychology

Throughout this thesis, the human component will be of primary interest, asking specifically to the experience of the player interacting with the virtual world. Lessons on how human understand and organize information in the framework of cognitive psychology will be recurrent phenomena for later topics, including story comprehension in Chapter 3.3 and the perception of spatial designs in Chapter 3.4. Ultimately the design specifications for the hypothesis and testing, should clearly exemplify the following concepts.

3.1.1 Information Processing

As a fundamental approach to sense-making as cognitive processes are the bottom-up and top-down. These functions are recurrent in specific areas such as perception, learning, and language comprehension. Bottom-up processes (11) (12), deals with the conceptualization and categorization of informational cues. As an inductive process, individual observations are grouped through inferences, to provide understanding about the perceived information. The natures of these inferences can be divided into two categories (11):

- *Minimalistic Inferences*: these are inferences that are believed to occur in the absence of goal-oriented sense-making. Inferences in this category are those that are quick and easy or those made to create local coherence, like bridging the meaning of two sentences or simple pattern completing in gestalt theory.
  The other inference drawn in the minimalistic category, are the strategic inferences, that are drawn to create global coherence by a goal driven reader.
- *Constructiuvistic inferences*: Also recognized as the search-after-meaning theory, this categorization of inferences assumes that many inferences are drawn and that these are of an elaborative nature. From these inferences detailed situational models are logically entailed, as conceptualizations of gathered information.

The result is an organization of information into what is called schemata, or also generalized as prior knowledge. An alternative aim of bottom-up processing is the ecologically minded perception theories of J. J. Gibson (13) with special emphasis on the concept of *affordance*. In this framework the observant, either human or animal, observe its environment to identify what functionalities it affords the observer. As such, Gibson offers the notion of varying levels of richness in environments, depending on what functionalities it affords the observant.

When the prior knowledge influences the reception of new information it is referred to as Top-down process. Here the reader deducts understanding and establishes expectations, by referencing already established knowledge and applying these onto his observation. It is however, believed information processing does not occur as a singular process on the functionality of being either top-down or bottom-up. Instead, it is expected that these occur as a parallel process (11), meaning that each process function simultaneously and are informant to each other.

3.1.2 The schemata

Schema-theory elaborates on information processing as described above. This theoretical understanding originates from the experiments and theories of the 1970's cognitive scientists (14 s. 21) and belongs to the field of experimental cognitive psychology (11). The Schemata can best be understood as a hieratical organization of knowledge into categories related by either meaning or situation. Scripts are schematas that detail causal events, like those we experience in the real world and narratives, the script can also describe a work routine or a physical exercise. Frames are schemata's relating to physical constructs (11 s. 383). Using the schemata allows the human, to draw inferences based on previous experience and thereby form new expectations.

Schema building is a continuous process in the pursuit of understanding information. As stated by Klippel "*the learner in schema theory actively builds schema and revises them in light on new information.*" (15). Windmayer further expands the understanding of how schemata's are constructed by introducing *accentation, tuning* and *reconstructing* in the strategy of assimilating new knowledge. The steps in learning are defined as follows:

- *Accentation* occurs the subject assimilates new information into his already existing schemeata without causing changes.
- *Tuning* occurs as the subject acquires new information that requires minor changes. This may simply be provided through a change in perspective, or by observing change on a temporal scale.
- Finally, *reconstructing* schematas are results of information that causes the subject to reorganize the knowledge already assimilated. An old, or wrong, schema is broken down and one or more new are constructed.

3.1.3 Sub-conclusion

This understanding of how the player assimilates and evaluates information introduces processes which provide a foundation for player centric level design. As previously mentioned, these concepts will serve as a foundation for later topics, but it will also serve as a model for constructing any solution in the final implementation.

3.2 The Argument of Time

Reading Jesper Juul's "Introduction to game time" (16), illuminates the temporal dimension as one of the central differences between interactive and non-interactive media. As will be examined in the later section 'Dramaturgy', time is a crucial element in the telling of non-interactive narratives, for building suspense. This section will examine how Juul classifies time in the interactive media of computer games.

In his ludogic study of time in games, Jesper Juul provides overview of the behavior of time in computer-games by establishing three concepts:

- *Game Time*: The time wherein a player engages the game, ranging from the start of the game until the end. This is limited either as the player abandons the game or until the game is completed. In effect, game time is established as the super-class for further categorization of concepts of time.
- *Play Time*: Play Time is the duration of time wherein the player is actively engaging the game, or game gameplay. Unlike Game Time, interaction is a prerequisite of interactivity, and does not cover cut-scenes, load screens or between-level result-screens.
- *Event Time:* Event Time is understood as the time occurring within the game world, and thus includes the time in which play occurs but also including the temporal duration that plays out in cut scenes and cinematic sequences.

The mapping that occurs between Play and Event time is of special notice. In games like *Unreal Tournament*[GT interactive, 1999] time shares a 1:1 mapping because the player is actively engaged in the gameplay and control is not taken away in cut scenes[1]. Other games, such as '*SimCity'* [Maxis, 1989] feature a different mapping, where a few minutes in play time, is narrated as half a year in event time. The game even allows for the player to speed up, or pause the event time, for strategic planning.

More importantly Play- and Event time are often forced out of synchronization, when the player meets challenges he is unable to overcome. The ability to save and load games, insures that play can continue as the player gets a new chance to go back overcome the challenge. Upon reloading the game, the player relives a length of the Event Time, and will in most cases be free to do so, until the perfect series of event leads him to the end of the game. It can be said, that the load and save function generates several minor game worlds each with their own sequence of events that are ultimately discarded. What remains is the ideal sequence of events where the Play Time exceeds the Event Time. This process of creating and discarding universes requires that the player reconstructs the games narrative after play has occurred.

3.2.1 Sub-conclusion

In summary, this examination of time in games, offers a very different set of functions, than in non-interactive media as well as reality. The fundamental difference here, as will be made more visible in the following chapter on dramaturgy, is how the temporal dimension has been placed in the hands of the player. In this way, the game designer affords the player an influence in the process of building and sustaining suspense in contrast to the non-interactive medium.

3.3 Dramaturgy

This section details a number of observations from film and narrative theory, including how time is used to create suspense and tension in the narrative, with the aim of isolating specific functions that can be transferred to the medium of computer games. This section will detail how David Bordwell defines his viewer and the cognitive processes of narrative comprehension. Finally, a perspective will be taken to the field of Narratology.

3.3.1 Classic Hollywood Drama

The previous chapter on time in computer games claims that time in cinema is a fundamental component for creating drama. This chapter will examine these aspects in pursuit of a generalization of such development. It should be noted however, that drama in film occurs on

---

[1] Unless the player is defeated, at which point he will return to the game after a brief view of the high score.

several other factors, such as cutting, music and acting, and further includes dramatic structures such as character development and symptomatic meanings regarding society, which will not be touched upon in this report.

One of the basic dramaturgical models is known as Freytag's Pyramid (or alternatively, Triangle)[3 p. 245] the model divides the narrative into the Aristotelian three act structure, with a beginning, middle and end. As it is illustrated in Figure 2 the pyramid describes the suspense connected to overcoming a particular complication. The suspense here rises prior to the actual resolution and drops afterwards as the narrative returns to the status quo that was established in the exposition.

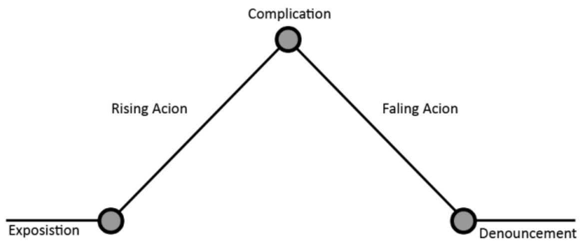


Figure 2: Freytag's Pyramid illustrates the rise and fall of suspense around a single plot point.

This dramaturgical model has often been translated to the medium of film, as can be seen in Figure 3. As based on structure proposed by screenwriter Syd Field (17 s. 199), it is very similar although with temporal significance. What is important to note, is the two plot points by which the story changes between acts.

Andrew Rollings and Ernest Adams further detail the model with more attention towards the minor dramatic peaks that plays out during the second act (9 s. 112). The first, located roughly 20 to 30 minutes in. We call this *the point of no return*. Up until this point in the story, most films have usually dealt with the status quo of the main characters. Showing who the main characters are and their daily lives.

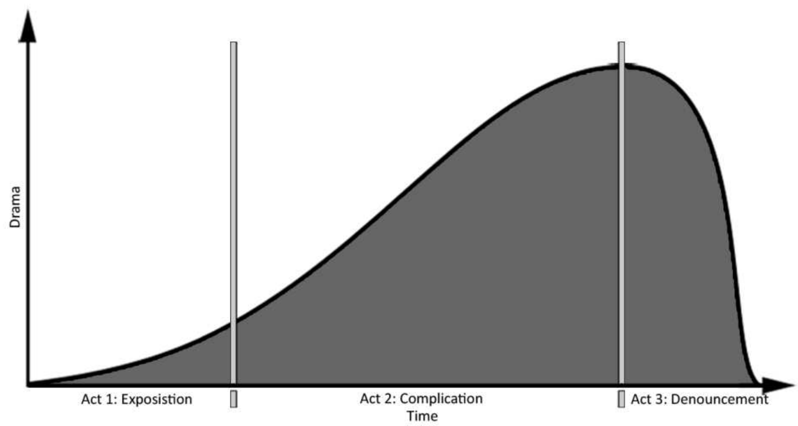


Figure 3: Dramatic suspense throughout the classic Hollywood model as the narrative progresses through the three act structure.

The point of no return introduces an irredeemable act, either by internal or external means that changes the status quo to a less ideal state. From here on and forward, the action plays out towards the final conflict that will serve to establish the new ideal status-quo by whatever means the plot allows. This could be either by resolving the main character(s) dramatic need, or eliminating whatever hostile threat is present as a few often seen examples. The Resolution is established as the second plot-point that finishes the second act of the story and opens up to the denouncement. As a question of the overall timing issues in cinema, what takes place in act 2 is aimed at delaying the resolution. What follows is a carefully orchestrated series of events that play out between the establishment of the main characters dramatic need and the conflict where he is able to resolve this. These obstacles include a several solutions as to delay the resolution. Plot twists are common, where a causal chain of events takes the main characters on a detour before the inevitable return. Other complications include car chases and attacks by the henchmen of the adversary, but these are only to name a few. Thereby, the temporal delay paralleled with the knowledge of the inevitable conflict that amplifies the drama.

3.3.2 Bordwell's Neo-formalist viewer

In defining his neo-formalistic approach to film-theory, David Bordwell (18) explores the activities of the viewer, as an active participant in reception of the film. Bordwell details how his viewer is constantly active in a cognitive sense, performing a process known as "story-comprehension", from which he makes sense of film he is watching. Applying what we have learned from the previous chapter 3.1, Bordwell explains that his viewer is picking up cues in the film and making hypotheses on the action of the film, by referencing previously established knowledge.

The notion of picking up cues describes the basic unit of story-comprehension: the cue. In film, a cue can be defined as any piece of information, object, speech and acting or even editing, that inform the plot and causes a progression of the narrative. As a bottom-up process, the viewer makes inferences on the basis of these cues to establish coherence in the film and describe what is going on. Through this process the Viewer procedurally assimilates knowledge of the film into narrative schemata that sustains his understanding of the film as it plays out.

In parallel to following the action, Bordwell describes the viewer as actively exerting the top-down process of hypothesis on the action of the narrative. These can be both assumptions towards further causality in the narrative or motivated as justifications for the actions of the characters. The knowledge, on which the Viewer formulates these hypotheses, can be derived from either the procedurally generated schemata belonging to the film that is currently being watched, or it can be referenced from other films. Referencing other films, is known as intertextual references, and can be motivated by similarities of genre, with plot elements or perhaps external factors, like the actors in the film or director. Whether based on intertextual schemas or the procedural schemata, the hypothesis formed by the Viewer should be regarded as elaborative inferences.

In this process the viewer will make several hypotheses on future events in the narrative; both best and worst case scenarios. As the narrative progresses, some hypotheses thought up by the viewer, will be verified or disproved. The viewer may well be forced to reformulate his initial assumptions several times, as the narrative progresses. While the above outlining of David Bordwell's viewer does not cover the full depth of narrative comprehension which he details - it does inform this thesis of how the player in a computer game can be expected to exhibit story-comprehension.

3.3.3 Narratology

Another approach to story-comprehension is the scientific field of Narratology. This study finds its origins in theorists such as Vlademir Propp (19) who deconstructed the Russian traditional fairytale into 32 unique functions that occurred frequently. The narrtologists propose a formalistic approach to narratives and deals as much with suspense as do other theorists. Fabula/sjuzhet is the Russians formalists approach to understanding the notion of time in narratives according to the form of the narrative. To describe this in further details, a beneficial introduction on labels on time can be included. This will bare a heavy resemblance to the denotations in the chapter 3.2 above 'The Argument of Time '.

- *Story time* (20) describes the events transpiring before, after and during the film. It includes background information that is referred to, even though it is not actually shown.
- *Plot time* (20) in film, describe what is similar to Jesper Juul's event time (16). Here the events presented in during the run of the film, as it plays out.

The crucial distinction to notice here is that an event transpiring in the story time does not have to be presented in the same order, during the plot time. Delaying the revelation of important information is an import tool to create the sensation of suspense. This process is recognized in the field of Narratology as *The Hermeneutic Code* (19), this is where the viewer follows the narrative actively building expectations upon the future action of the narrative thereby kept in a state of suspense. The Hermeneutic Code relies on visible causal chain events, or at least visible enough for the viewer to deduct one or several other possible outcomes from the line of action. The suspense tied to an actions resolution is known *The Proairetic Code* (19). Following in line with the Hermeneutic code, the viewers hypotheses of what will happen if his expectations are met as another tool for keeping the viewer in suspense.

3.3.4 Sub-Conclusion

Two factors have been drawn from the study of cinema, the standard model for suspense and the cognitive activities of the viewer. In the first case, it is evident that knowledge of oncoming events, allows for the viewer to build suspense around the resolution of the story. The second case supports this as it provides a detailed foundation for understanding the method by which the viewer actively engages non-interactive media by processes of cognition. The transferability of each case, to the interactive medium of computer games, has of cause already been done with varying degrees of success. Through the remainder of this report, a model will be build this suggests a dimensional shift from time to space.

3.4 Spatial Cognition

This section of the report explores works made in city-design. These provide a view internalized view of how humans navigate through real-world cityscapes. Similar to already visited narrative theories of film, the understanding set forth here can beneficially be transferred to the navigation the player must perform, and as thereby also as tools for level design.

Under research in urban planning Kevin Lynch (21) takes his theoretical offset in the citizen. This is a descriptive term for the human being whose understanding of the city conceptualizes a foundation for the new urban planners to incorporate into their designs. His focus on this citizen emphasizes self-localization, way-finding, and the spatial primitives that the citizen applies to establish a perceived mental "Image of the City". This shares undeniable similarities with Ryan's established model of space (4) when she describes the spatial immersive experience in virtual environments.

Alexander Kippel elaborates in his master thesis (15), establishing a bottom-up reading of the city, differentiating between the five spatial primitives that are isolated by Lynch, of paths, edges, districts, nodes and landmarks.

- *Paths* are described as the primary concept of understanding city layouts. They are physical objects that connect the different elements and can also take important roles of the following concepts. Examples of paths are given as walkways, streets, transit lines, canals and railroads.

- *Edges* describe linear boundaries that force a detour. Walls, as well as dykes and ditches are given as examples.
- *Districts* define different areas within a cityscape. The distinctive features that tie these areas together could be the time period in architecture, the segment of citizens living in the area, cultural or industrial influences.
- *Nodes* serve as points of interconnectivity and thus build further on the notion of the paths and edges. Examples given of nodes are street crossing or other junctions of paths. It could therefore also be suggested to include areas of converging transportation systems.
- *Landmarks* are buildings or an object that lends themselves as points of reference. These are noted as being "from the outside" only, underlining that citizen does not need to enter a building for it to be a landmark. Examples include statues, signs, mountains, town squares, special buildings or noteworthy buildings.

Three of the above concepts are conceptual, Districts, Landmark and Nodes, incorporating the notion of edges and paths in their composition or an unmentioned factor, which are the previous and personal experiences of the citizen.

Kippel further explores this notion of "the world inside our heads" through the work of Roland Golledge (15). Golledge's exploration of way-finding principles opens up to internally represented *occurrences* that are perceived by the citizent, contrary to the physical objects that were the basis of Lynch's research. In result, Golledge defines four *first-order spatial primitives:*

- *Identity* signifies the singular occurrence and thereby allows for recognition and evaluation.
- *Location* identifies the basic information of a place where the occurrence exists.
- *Magnitude* describes how many times an occurrence appear in a specific location. This could be the repetitions of commercial banners as easily as duplicates of the same physical object.
- *Time* indicates the interval when an occurrence appears.

The final two items, Magnitude and Time, is of special interest to this thesis, as it determines a relationship between temporal and spatial occurrences. This allows us to think about occurrences in leveldesign, with a sense of timing that is determined on a spatial scale.

3.4.1 Sub-conclusion

Lessons learned from the study of way-finding outlines which concepts are fundamental for the design process if the aim is to give the player a, if not natural then logical, understanding of the virtual space. While the objects described by Lynch are easily transferrable to the formal structure of the level, and its visual design, Golledge's spatial primitives introduce a set of very descriptive variables for each of these objects that offer a temporal/spatial solution to timing issues.

4 Final Problem Formulation

The pre-analysis clarifies the argumentation that time has become less manageable in computer games because the occurrence of dramatic events are decided by the navigation of the player. Challenging this, the pre-analysis also shows how classic dramaturgy relies very much on the concept of time for creating suspense. In the constructivist understanding of David Bordwell's neo-formalistic film theory, this is done by motivating the viewer into a goal-oriented process of hypothesis making, where the viewer is actively sustaining coherency in the narrative he is being presented, while trying to guess how the main character overcomes his dramatic need. Similar functions are found in the school of Narratology, where the hermeneutic code especially, allows the reader of a text, to make assumptions towards the later action. He is, so to say, kept in suspense.

This conflict of timing in computer games allows a further specification to the initial problem formulation that proposes narrative suspense as separated from the temporal domain and transferred into a spatial-narrative domain.

Studies of cognitive psychology tie together concepts of how space is perceived, through Lynch, Kippel and Golledge with how narrative structures are understood in film by cinematic theorist, David Bordwell. This commonality suggests that spatial understanding can support narrative dramaturgy to create a high state of suspense without the time as a controlled factor.

This leads to a revision of the initial problem formulation into its final formulation:

Final Problem formulation:

"Can cognitive psychology support an analytical model that explain the user experience of levels in computer-games as spatial-narrative constructions?"

4.1 Project Delimitation

Unlike other non-interactive media, computer games are very diverse and between two genres, the points of actual comparison of two games can be very few. To keep the project manageable within the given time-frame and resources, the focus of the further report will be kept on action/adventure games. The reasons for choosing this genre include:

- The genre supports stronger narratives than most other, as an incentive for the player to immerse himself to a higher degree (9 s. 90).
- Challenges presented in the action/adventure genre are diverse and include narrative based challenges, combat oriented, puzzles and also path-making challenges.
- Unlike Real Time Strategy and Survival Horror, games in the action/adventure genre are less restrictive with the camera usage, and often explore 3d environments to the fullest.

4.2 Initial Hypothesis

It is the initial hypothesis that an analytical model can be devolved for how the Player experiences levels in computer games. This model will be structured similarly to the cognitive processes for understanding, wherein each step will be informed by an analysis surmising common points among theories associated with both computer games and other interactive environments.

5 Analysis

The following chapter will go into the research needed to specify a model of understanding, which will answer the problem statement. This research will take three major parts:

- The first section, on The History of Levels explores the functionality of levels in contrast to evolution of the medium.
- Design of interactive spaces explores the different perspective of creating engaging space in art installations and as theme park rides. Here, with emphasis on the functionality of how the visitors navigate.
- Design of virtual spaces is the following chapter that examines functionality of certain levels, as outlined by veteran level designer Phil Co.
- Models of Interactive Narratives: Focuses on formal structures suggested for interactive storytelling, and transferring these to support level design.

Reiterations of already established concepts are going to occur as the analysis narrows in. Identified occurrences of previously established concepts can be regarded as the emergence of an underlying pattern in spatial storytelling. The output of this chapter will go into a discussion that condenses the analysis and informs the eventual design specification for a prototype test design that can answer the problem formulation.

5.1 The History of Levels

In the context of history, the last 30 years development of computer games can easily appear overwhelming. The steady increase in technology paralleled by numerous innovative game designers can make it difficult to discern each important evolutionary step of the media. Within the context of levels, this is very much the case.

What is presented hereafter, is an attempted following of computer game history with specific empathizes on the significant advances within level design. Special attention will be directed towards the method of how the content of the game is being presented to the player. To investigate this, two concepts are suggested:

- The concept of *Game World*, will be understood as the domain of the fictional world as a holistic construct. This includes that space which is implied by the game, through such methods as maps, but not experienced by the player.
- The concept of *Game Space* is subsequently, the space in which the player is presented with by the game. As such, the game space is the sum of every level of the game.

Since no literature has been uncovered in this regard, the analysis will be based purely on observation. It should also be noted, that as much as possible, this will disregard limitation set down by technology. While it may have served as barriers at the time of development, it is beyond the scope of this analysis to include a refined measurement of processing requirements for the various games.

5.1.1 Static Levels

Significant to the game space in early games, is that it is restricted by the screen size and resolution. And the game would never escape the borders of the setup. '*Space Invaders*' [Midway, 1978] is a good example of how games initially existed within one static level, with the player positioned in a 3rd person point of view. Here the player was charged with the defense of the planet, facing an armada. Once the player had eradicated the enemy threat, the level would restart with the same graphical content. The challenge was however increased as the remerging enemies.

As shown in Illustration 2, the classic title '*Tetris*' [Alexey Pajitnov, Nintendo, 1985], reinforces the notion of having no separate levels at all, but instead raising the speed at which the puzzle pieces comes falling. This happens with regular intervals as the player passes certain point scores. The player gets less time to position the puzzle pieces and this eventually forces him to make mistakes that will cause him to lose the game.

In some instances, this method to level design is still a viable option that is used. Casual Games often create static levels that are easily approachable for the user, and cheaply produced. The level design of tennis and similar sports games are also restricted to the confines of one level. It can be argued that randomly generated game worlds, Like '*Sid Meyer's Civilization*'[Microprose, 1991] also applies this method. In these examples, it should be noted, that the game space does exceed the screen space on which it is presented.

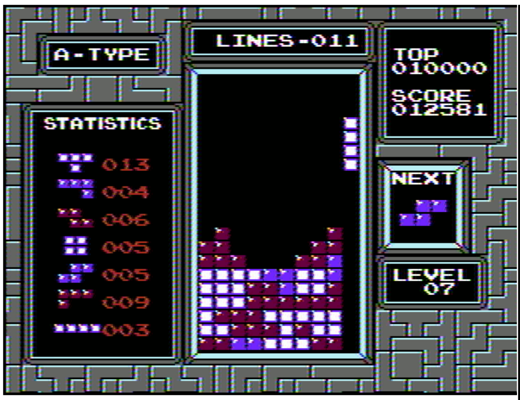


Illustration 2: Tetris II (NES version)

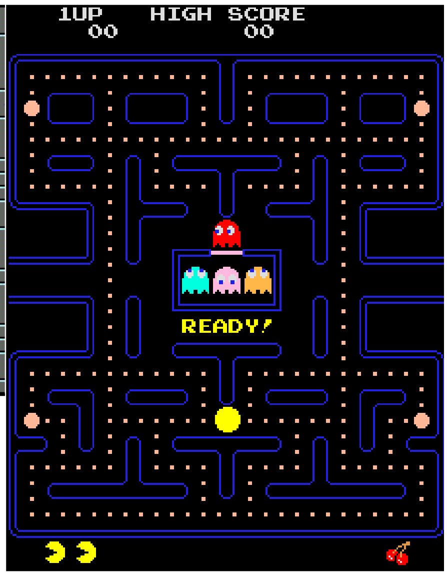


Illustration 3: Pacman

5.1.2 Reconfiguring Levels

The Classic games like '*Pacman*' [Namco and Midway, 1980] as seen in Illustration 3, introduces the notion separate levels. Here, the gameplay occurred within the confines of a maze which the player would view from an omnipresent point of view. As the player successfully collected all points that were distributed throughout the labyrinth, without being defeated by the four ghosts, the level would be completed. He would then progress to the next level of the game. Throughout the games 256 levels, the configurations of the labyrinth structure would change, presenting a higher challenge to the player.

Pacman thus establishes the notion of levels as discreet units of the Game World that the player has to progress through. In this, and similar games, it is important to note, that while the content becomes interchangeable, the Game Space, is still tightly connected with the screen space.

5.1.3 Linear Levels

The introduction of scroll-games, or platform-games, such as '*Super Mario Bros.*' [Nintendo, 1985] (See Illustration 4) followed with the introduction of the Nintendo Entertainment System (NES) further establishes the concept of levels as discreet units of space.

Here the game space had broken away from the screen, as the game was presented as a world panning forward, to follow the avatar of the player. Successfully completing the each level and game were a simple matter of proceeding forward through a series of challenges, as shown in Figure 4. New levels would introduce new challenges such as new types of enemies, or an increased number thereof, proving it more difficult to progress through the game. Similarly, the visual theme of the level would also change, from exploring a wide open field, to the insides of a haunted castle.

Figure 4: Linear level progression through the game world.

Illustration 4: Super Mario Bros.

5.1.4 The Complete Game World

The notion of the Complete Game World as the game space that ties together the individual levels is visualized in the success game '*Super Mario World*' [Nintendo, 1990]. Here, a part of the gameplay revolves around choosing which levels to play next. In this manner, some levels are accessible as the player progresses in a linear fashion, while others requires keys that leads the player through major detours around the game world.

An interesting evolution that is available here is the possibility for the player to return and replay levels which has already been completed. Revisiting certain levels on a later stage of play will actually allow the player to start some levels with significant advantage. Navigating the game world thus becomes a challenge in itself that adds a labyrinth to the gameplay. Providing the game space as a navigational challenge, is further expanded with the introduction of 3d games like '*Doom*'[John Romero, ID software, 1993].

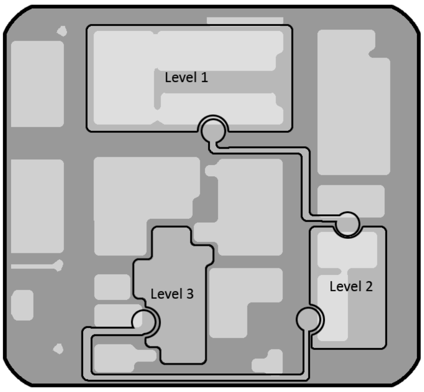


Figure 5: A possible game world super exposed over a city map

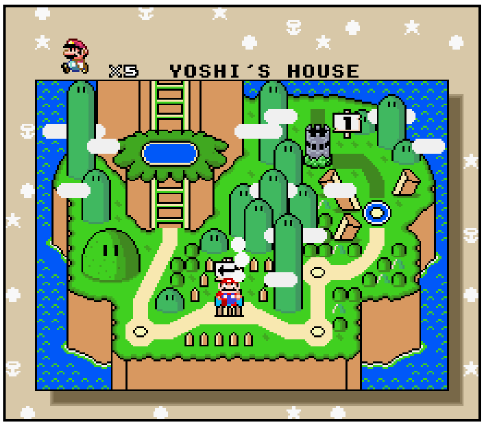


Illustration 5: The game world of Super Mario World

While the notion of a widely accessible game world is by no means a standard in any established genres, it is still used quite frequently. The approach to this as exhibited in '*Total Overdose*' [Deadline Games, 2005] and the '*Grand Theft Auto*' [Rockstar Games, 2001] series, makes a good example. An alternative example of this method could be found in the popular massive multiplayer online games (MMO).

In Total Overdose the game world is composed of the area surrounding the fictional city of Los Toros. The player is free to roam the city and take on whatever missions he finds, while advancing in the games overall narrative requires performing a set of specific missions. This provides the player with a degree of freedom, as it establishes a nearly complete 1:1 mapping of the game space and the game world. Most of these missions take place within the already established game world and as such, ties the action of the game to the game world. In a more traditional manner, some missions do transport the player outside the city, and into otherwise, unavailable levels that must be completed before returning to the city of Los Toros.

5.1.5 Sub-conclusion

This overview of how levels have changed with time, shows that the game space have grown to nearly encompass the entire game world. This suggests a trend towards a more analog usage of space, contrary to the discreet units that we have previously known.

That is not the case for all game genres. And many modern games are still produced with linear or reconfigurable levels. The classifications provided above, should therefore not only be thought of, as the historical evolution of games, but also as developed methods, through which the game space can be presented to the player.

5.2 Design of Interactive Space

Spatial narratives and space as entertainment is far from a new tradition. The oldest recorded narrative we have is the Odyssey by Homer (22), which plays out as one large voyage home. This section deals with some of the more recent spatial narratives, although here, the context of 'computer games' are left behind and the focus is shifted to art installations and lessons learned from the theme park industry.

5.2.1 Space as Entertainment

When Don Carson specifies his experiences within the design of theme park rides (23), he goes closely into the guiding of the guests and what experience is in stored for the guest to experience. Firstly, these are not interactive spaces as are computer games where walls can be broken down at a very safe execution of some code. In fact, the volume of possible guests matter greatly. In order to get many guests through quickly, Carson reviews notions of guiding the guest.

Storytelling through *causality* is one such method. An area may well be staged with information that combines in the same way a murder scene would, once the guest piece together the mystery, they will know in which direction to go. This makes the guest into his own guide, and offers an intellectual challenge to the experience. In best case scenarios the guests will feel gratified by solving the puzzle. To difficult challenges will of cause, get them confused and lost.

A *guiding* method described by Carson, is called “Following Saknussem”. Here he implement the trail of bread crumbs that will lead the guests further in the ride, by giving them small pieces of a parallel story. The dubbing, “Following Saknussem” refers to the Icelandic scientist that made his way down before the main characters in Jules Verne’s’ Journey to the Center of the Earth (24). This notion of providing a trail of bread crumbs, parallels directly to the notion of ‘Paths’ as proposed during the pre-analysis, although it is a slightly implicit path. The tradeoff for that is the implementation of a supporting narrative.

Exploring the level of detail in the various spaces, Carson approaches this notion as “Less is more”. Here he exemplifies how an area with dense details will be confusing, while specifically detailed items will stand out in a more simplistic area. In this way, contrast is used to guide the guests’ attention and therefore also their movement.

The notion of using *contrasts* is also explored in the frame of experience; that a narrow and small room may come just before a large open domain. Other suggestions include order contrasting chaos, warmth and cold, and very interestingly grids contrasting noise. The premise is to establish expectations for the guests, allowing them to get comfortable to one environment, before shifting to the other.

5.2.2 Space as Art Installation

Installation artist Ilya Kabakov[2] (25) is well-known for producing interactive installations where the viewer is free to position himself, through these; he has developed an elaborate strategy for guiding the viewer’s navigation through the installation[3].

Kabakov‘s theory were founded on the notion that the viewers movement through the virtual landscape defined the time/space relationship in his dramaturgical setup. Kabakov divided installations into two or more connected spaces, and created well defined paths between these. To guide the viewers through such paths the following strategies were suggested;

- Abrupt openings in corridors and ‘strange objects’ used to obstruct passage would define the path for the visitor. The description introduces illogical occurrences within the virtual domain – which may be desirable in arts, but this is quite a different notion in computer games, where the virtual environment attempts with increasing effort

---

[2] Two pictures from the 1968 installation “The Man Who Flew into Space from His Apartment” can be seen in appendix c, although visiting the falsh website will provide a better understanding of the art work.

[3] The following section is summarized by Lev Manovich in his essay on Navigable Space (18)

imitates the physical. The divergent train of thought does however clearly identify the conception of clearly defined openings and barricades.

- Another proposed strategy is found in designing interactive spaces according to narratives which lends themselves to spatial exploration. Examples could be 'search and rescue' based narratives. The fundamental consideration is the beginning and end of the narrative, the duration of time in between, the search, can take as long as the viewer chooses to invest.
- Finally Kabakov suggest the placement of text inside the installation, which is intended for the viewer to read and follow as he goes along. A downside to this method of guiding is that it may seem overtly rigid, but in fact the introduction of an active *narrator* for explicit guidance has yet to be introduced into this analysis.

5.2.3 Sub-conclusion

In physical installations such as the two variations we see above, the navigation is very highly prioritized. In the entertainment industry of theme parks, navigation is approached with concerns for guidance where as the artist describes strategies for delivering information to the audience.

A distinct commonality between the two; is Kabakov's narrator and Carsons guiding principle through the method of "Folloiwng Saknussem". Not only does the narrator help the audience progress through the installation with little risk of becoming lost, but at the same time, the narrator is able to deliver its information in a manner that supports or even constructs the narrative.

The application of contrast between architectural spaces and detail level, as well as using strange and illogical details to direct attention, are also interesting when approaches to the communication process between the artist or developer and the audience.

5.3 Design of Virtual Spaces

Lessons learned from practical Game Design (8 s. 82-88). Level designer Phil Co, defines in his book "Level Design for games – Creating compelling game experiences" (8) three different overall concepts for level design. These are the standard level, the hub and the boss level. Additionally he also mentions the bonus level.

5.3.1 Standard Level

The standard level introduces and maintains the modus operandi for the game. It is emphasized that these levels contribute to roughly 90% of the game and that challenges may vary to keep the game fresh.

Observations suggest that while the standard level maintains the game play of the game, it is in fact very common that levels change between different environments as the player progresses. The complexity of challenges proposed to the player also increase as he moves further through the game.

5.3.2 The Hub

The hub is a transitional level that ties the standard levels together. To a wide extend the game worlds of '*Total Overdose*' and even '*Super Mario World'*, as mentioned above, can be thought of as Hubs. From the hub, the player gain access to the standard levels of the game. Usually he only one or two options at first, but as play progresses more exits will be unlocked.

Connecting the standard levels is not the only use Hubs serve. Many RPG styled games use hubs as the player's possibility to deal with merchants. In this genre especially, hubs also serve as a narrative platform, for the player to receive quests here. Blizzard Entertainment's '*Diablo*'[Blizzard North, 1996] crystallizes these examples clearly.

Other games, such as '*Resident Evil II*' [Capcom 1998] contains a number of hubs which are subtly integrated into the standard level, here the player has access to his save point and extended inventory, but the gameplay is maintained in the form of horror and the reoccurring zombie attacks.

5.3.3 Boss Level

The boss level historically marks the conclusion of one or more standard levels. Here the player is faced with a particularly difficult antagonist. The level is often quite small and keeps the focus on this single conflict resolution. In newer games, several minor bosses may also be encountered throughout the standard level. The game-play is also changed sometimes. Phil Co mentions the example of '*Harry Potter and the Chamber of Secrets*', where the camera locks in the final conflict.

There are several key aspects of the boss level that could be added to Phil Co's specification.

- Unique antagonist. By convention, computer games reuse enemies very often. Commonly every other type of enemy will keep coming at the player level after level, until trivialized. The boss is commonly unique although some instance, like the intensely frightening Pyramid Head of '*Silent Hill 2*' [Konami, 2001] the boss reappears near the end of the game.
- Non-dietetic elements such as the background music commonly changes during the boss fights. This is clearly witnessed in '*Super Mario World*' [Nintendo, 1990] among other games.
- The boss level often entails a strong narrative content, signaling the end of an act as visited upon in the pre-analysis chapter 3.3 Dramaturgy.

5.3.4 Bonus Level

Bonus are rarely integrated into the narrative of the game, but instead serves the purpose of either resupplying the player with power ups before a significant challenge, or providing rewards for specially diligent players.

5.3.5 Sub-conclusion

To summarize the given categorization above, one could easily ask for more evaluative information on the different types of levels, when reading from the experiences of a veteran game designer. As very practical classes there is a reward in the illumination of hubs as 'transitional spaces' and boss levels as parallels to the narrative resolution of a conflict.

5.4 Models of Interactive Narratives

This section suggests a mapping of narrative and game-play elements, to the interactive models isolated by Ryan (4), to abstractly describe the relationship between occurrences in particular levels. The following walkthrough, between selected models of interactivity, will be elaborated with an integration of previously learned lessons to emphasize spatial storytelling.

When engaging an analysis of interactivity, Marie-Laure Ryan explores the structures that would possibly allow for narratives to play out. Although her approach is aimed at the holistic act of storytelling, including dialogue and other forms of interaction than spatial ones, this analysis can still be purposefully re-read in the context of levels. The outcome of this will be a number of formal structures that serve as the underlying pattern of levels.

Ryan identifies the instances, where possible interactions occur as “nodes”. Each node provides it’s in- and outputs via paths. The paths that connect nodes can also be either uni- or bidirectional, depending on how they can be accessed. As abstract diagrams these structures does not necessarily hold any specific relation to Cartesian space, or temporal relations. Instead they are merely organizations of the interrelationships between nodes.

5.4.1 Nodes as Micronarratives

The naming conventions which are used by Ryan collide with those applied by Kevin Lynch, as described in chapter 3.4. Before this sections proceeds through the models of interactivity, the concept of nodes must be re-evaluated in the scope of level design. Ryans’ interest in paths on the other hand, is limited to the connectivity they provide and are not elaborated on further. As such this conflict with Lynch’s conceptualization of paths will be ignored.

To this point we return to Jenkins, whose article also informed the motivation for this thesis. Jenkins suggests that narrative action in computer games can be classified as *Micronarratives* (7 p. 125), which are short sequences of conflict. The micronarratives can bear more or less weight on the overall narrative of the game, but they do not necessarily have to.

Outlining the symbolic drama of games, Janet Murray lists a number of events describing narrative units in computer games (5 s. 142) among these several could ideally occur as micronarratives in the course of a level:

- I take a risk and am rewarded for my courage.
- I encounter a difficult antagonist and triumph over him.
- I encounter a challenging test of skill or strategy and succeed at it.
- I am challenged by a world of constant unpredictable emergencies and I survive it.

This understanding of micronarratives as smaller units that composes the larger narrative can with benefit be used to structure level design and replace the concept of nodes in interactive structures.

5.4.2 The Completed Graph

This is the first model approached by Ryan. This very open structure is taken as example from the hypertext media. Here, every micronarrative allow for access to any of the other nodes without a sense of direction or end. Interaction here is reminiscent of browsing the internet, as there is little coherency between nodes. All micronarratives are connected via either bidirectional paths as visualized in Figure 6[4].

In the terms of spatial design, the completed graph illustrates how movement works in a very fundamental aspect. Each point in this design provides access to its adjacent points and the player can freely roam the level. Spaces such as football playing fields or other obstacle free environments are included in this model. Spaces of three dimensions, such as ‘*Descent*’ [Parallax Software, 1995] add another level of complexity to the graph and are also well described by it.

[4] Figure 6 is a recreation of that presented in “Narratives as Virtual Reality” (4 s. 247). The model has been simplified and arrows have been added for visualization of bidirectional paths.

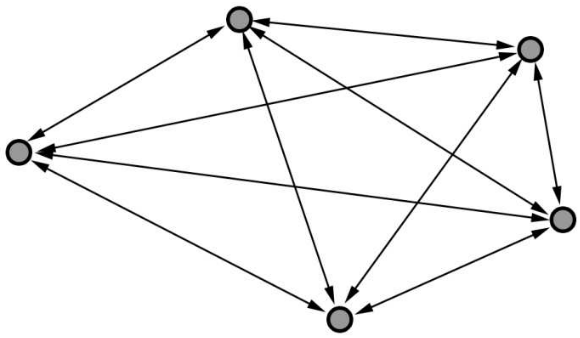


Figure 6: A bidirectional version of The Completed Graph

5.4.3 The Maze

The maze is a variation to the completed graph. In this model, the interconnectivity between every single micronarrative is not guaranteed, nor is the directionality of paths. As such, navigating from one end of the game space to the other becomes a challenge in itself, this is often referred to as "space as an obstacle" (5). This notion of the maze is commonly used in computer games. Often game designers have used this model as an opportunity to increase the time it takes to finish the game. Games like '*Silent Hill*' [Konami, 1999] are notorious for suspending the narrative as the player moves through a set of very long mazes. Ironically these are often no more complicated than passing through an apartment block or reaching room 207 in a hospital, but to get there, virtually every other room most be investigated and the player is likely to enter and exit hell before reaching the destination. As such, it makes sense that the maze allows for backtracking and circular movement.

Paths in spatial narratives are most often bidirectional, as the player can always turn around and revisit past locations. The most common exception is the locked door, or by other means, impassable obstacle. Here we re-iterate the established notion of checkpoints, as described in the Games Ontology Project (10). To overcome a locked door, the player is set out on an implicit side-quest to regain the key (or another object) that will allow him to proceed.

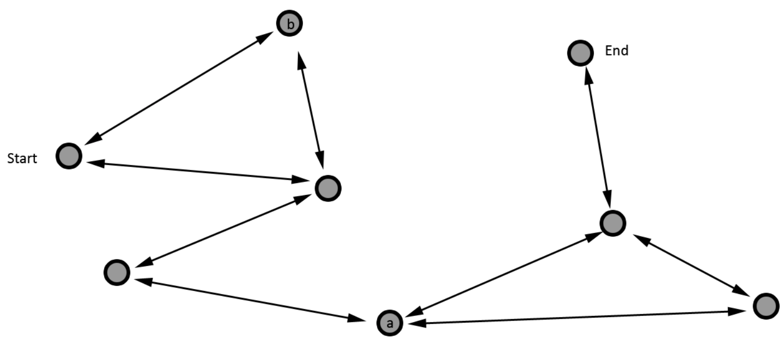


Figure 7: The Maze

Figure 7[5] shows a simplified maze structure with a start and an end. Micronarrative 'a' could include a locking mechanism that requires the player to retrieve a key item located in at location 'b'. The result would be a prolonging of the game play, which may to some degree be indifferent to the progression of the narrative plot. This brings back a concept that has previously been touched upon in the pre-analysis in chapter 3.3, how the second act in film delays the resolution of the narrative to build suspense with the viewer. Furthermore the bottleneck function, that micronarrative 'a' becomes in this example, is an ideal location to deliver crucial information to the overall narrative.

5.4.4 The Vector with Side Branches and the Directed Network

Two other models stand out as fine examples how level have occasionally been designed, these shares a number of overlapping properties and can therefore be presented simultaneously. The *vector with side branches* and the directed network are both variations to the linear structure that we recognize from old platform games.

Both of the above mentioned graphs rely on an instilled sense of direction. In Ryan's examples of interactivity, the noteworthy change is the unidirectional introduced into a common vector. As such the notion of a 'main' course of action, or main storyline emerges. In its simplest form, the notion of the vector in introduced in Figure 8.

Figure 8: Ryan's vector illustrates a main storyline progressing over time.

The vector is a very common item in "side scrolling" or "platform" computer games like '*Super Mario Bros.*' [Nintendo, 1985]. Other, far more complex games can also be said to support this simple and linear structure. Racing games is one example. Whatever the player does, he cannot escape the forward linearity of the racing track without actually loosing the game.

In a more complex example, the spatial design of a level may include dead ends. We have already visited upon the notion of bonus levels in chapter 5.3, which is one suggestion for such a dead end branch of the vector. But there may well be others who are more or less unjustified, especially in games where spatial navigation is an objective to be dealt with; a dead end can be an interesting complication.

Figure 9[6] shows an illustration of such an example. Ryan's vector with side branches includes a number of shorter or longer paths that the player can engage on through. Maybe there will not be enough information to discern, which is the ideal path that will lead to the games objective, or perhaps the detour will be an obvious chance at power ups or a higher score at the end of the level.

[5] Figure 7 is a recreation of that presented in "Narratives as Virtual Reality" (4 s. 251). The model has been simplified for easier understanding and 'a' and 'b' node denotations have been added.

[6] Figure 9 is a recreation of that presented in "Narratives as Virtual Reality" (4 s. 250). The model has been simplified to increase understanding.

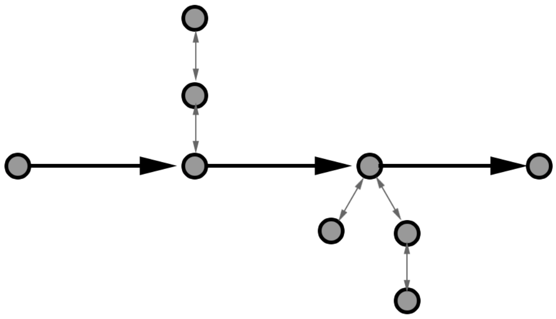


Figure 9: Vector with side branches

The Directed Network as illustrated in Figure 10[7] is a slight variation where one or more branches may divide at a certain point, but whichever the player chooses to follow, eventually leads to the end of the level. This allows for short cuts, which are favorable in some instances, but also jeopardizes the ongoing narrative of the game.

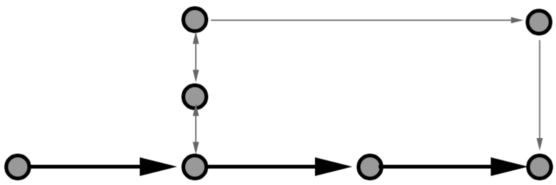


Figure 10: Directed network

5.4.5 The Loop

An additional structure of interactivity in level design that can be added here, is the loop. As shown in Figure 11: **The Loop** this structure introduces a localized incident with two possible outcomes, '*a*' and '*b*'. *b* is however inaccessible due to circumstances tied to the narrative playing out. To move forward, the player is forced to take a detour, which is quite common.

From what have already been researched, this model could have been described as either The Maze or either variation to the vector. The important difference from these models lies in the design that loops but does not revisit other segments of the level, other than the pivotal micronarrative that presented the fork in the road. As such, the player does not have to backtrack, which may save him from some confusion. Especially in games that hold to a strong main storyline.

[7] Figure 10 is a recreation of that presented in "Narratives as Virtual Reality" (4 s. 252). The model has been simplified and the suggestive multiple endings have been removed.

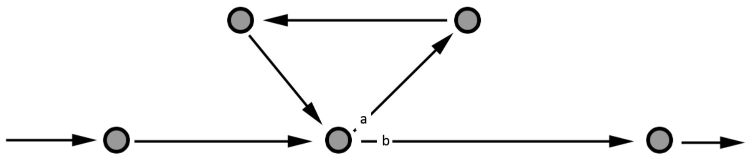


Figure 11: The Loop

5.4.6 Sub-conclusion

The structures above summarize the fundamental building blocks of levels, divorced from graphical content and without the representation of any entities. It would be easy to assume a certain degree of simplicity within level designs once the cosmetics are removed, but the collection of structures above argues otherwise. As a production oriented tool, these structures can be combined and elaborated into more or less complex levels.

It should be noted that the transference from Ryan's interactivity to navigation has proved to be logically viable in all instances; this is due to the simple understanding, that navigation is interaction. However, the interaction sought after by Ryan goes to establish interactive narratives in a broad scope. In the context of this analysis, spatial interactions will occur far more frequently as the player is far more likely to be offered different paths through the level. In most cases, the player also has the ability to revisit old locations, which makes bidirectional paths more of the norm than the exception. In narratives this would be the reverse, as one makes a choice it that changes the story, it cannot be undone.

Finally it should be noted that as a vocabulary, a few reformulations may be in order. It is perfectly legit for a narrative author or game designer to use the word 'vector' in a weak and ambiguous way like above, but for a level designer, that and usage of terminology may well cause confusion when communicating with technical departments.

5.5 Hypothesis

On the basis of the research summarized throughout this chapter, three hypotheses can be formulated, that answer the final problem formulation. This section will introduce these, with the initial considerations for further testing.

The pre-analysis indicates that cognitive psychological processes of learning, as visited in the pre-analysis chapter 3.1 can provide a framework for the player's understanding of the level, drawing a parallel to David Bordwells neo-formalistic 'Viewer' which was described in chapter 3.3.2. The following hypothesis is made under the presuppositions that the player is actively in a state of sense-making, based on the information he perceives in the environment. These informational cues, should be considered as those visited in the analysis above.

The motivation and processes of the Player should therefore be similar to those of Bordwell's Viewer. This entails that the fundamental processes of the viewer can transferred to the player in the following three hypotheses:

5.5.1 Hypothesis 1: Base case

It must first be verified that if the collected information above, is organized and implemented into a prototype, the player will perform better than if he was presented with a fully naturalistic environment without narrative-spatial elements.

"An environment, richly detailed with narrative/spatial information presented in analysis, will yield a better navigational performance from the test subject."

In a navigational situation this will be evident by a measure of how fast the level is completed. Not only because navigational tasks becomes easier for the informed player, but also because narrative cues will guide a forward progression.

5.5.2 Hypothesis 2: Conceptualization

"The player will in a process similar to Bordwells' narrative theory and create and maintain a mental model of space he is located in."

This hypothesis points to the player's conceptualization of the level which he is engaged with. The information provided through the level architecture and the occurrence of events within it, is managed by the player into, at least two categories:

a) The player will identify and conceptualize elements of the level.
b) The player will recognize spatial patterns.

5.5.3 Hypothesis 3: Path-making

"*Based on this mental model of space, the player will actively plan routes through the environment.*"

The final hypothesis proposes that the player is actively engaged in the process of planning his future route through the level which will be based on his understanding of the level. This route will be planned based on prior knowledge, and his expectations towards the level.

5.5.4 Considerations for testing platform

The hypotheses above are stated as phenomena sustained by the player as cognitive processes, therefore they are logically transferable between different types of setups where computer games occur. This includes consol game systems, PC, Virtual Reality systems and handheld devices such as phones and specific gaming consoles. A notable exception though, would be the Augmented Reality systems that introduce physical reality to the game and as such, have great influence on the player's evaluation of space.

It is beyond the scope of this thesis to test on each of the mentioned platforms. The criteria for choosing one type of setup above the other, is therefore made on availability. The PC is chosen for its obvious availability which in turn, allow for parallel testing. Developing a game prototype on the PC also offers a wide array of game engines.

5.5.5 Considerations for test demographics

A similar consideration is made in choosing the best test population. The ideal demographic (which will be further described in chapter 7) will be regular gamers, who have the skill needed to be evaluative on their gaming experience. This means that they should be accustomed to the interface controls, and will easily abstract from the elements which will not be included in the prototype, such as intelligent characters, weather conditions and the like.

The demographic should not however, be chosen among students who already study computer games, since such prior knowledge may cause them to analyze the experience from an unbiased point of view. This could for example, be students who choose to align themselves as either narratologists or ludolgists.

6 The GRID Model

This chapter will discuss the research provided in the analysis chapter and refine the lessons learned, into suggestive model for understanding how the player perceives spatial structures. This analytical model will be dubbed the GRID model[8] for future reference. The model incorporates the understanding gained in the pre-analysis and expands upon the lessons learned in the analysis. This chapter will go through the various sections:

- Levels in computer-games are argued as both spatial and narrative constructs.
- The GRID model examines the player's conceptualization of the level as in bottom up processes.
- The GRID model examines the player's deductive processes as top-down processes.
- The GRID model examines the player's path-making abilities within the resulting mental modal of space.

In the design of interactive spaces, the process is a two way communication between the developer and, in the case of computer games, the player. The GRID model collects the information provided during the analysis, and presents it in a player-centric fashion. It is the expectation that this point of view, will allow the model to be used for two purposes. As an analytical model for levels in computer-games, and as an approach to development that keeps the player's experience of the level in focus.

The procedure in which the player experiences the level is explained first, from a bottom-up perspective and subsequently as a top-down process. In this effort, the elements proposed by Kevin Lynch in chapter 3.4 weigh in heavily. Finally, the model proposes how parallel processes could be occurring for the player while navigating levels in computer-games.

6.1 Space as Narrative

Before these items are investigated 'levels' must be identified as a construct of both space and narrative. Reconciling these two items requires loosening the grip on physical reality slightly.

From the historical examination levels in chapter 5.1 it can be argued that while the general progressions through levels in computer games have had an increase in possible paths as the medium evolved. The player's progression through the entire game is still aimed towards the single goal that is needed to advance to the next level, and thereby the narrative. In the example of *Super Mario Bros.*(Nintendo, 1985**)** this is simply the challenge of reaching the opposite end of the level. Games like *Hitman*(IO interactive, 2000) elaborates on this challenge, as it requires that the player arrives at one certain place that allows for a specific assassination to take place, which influences the narrative content of the game. Chapter 5.4 introduces the notion of different paths through the level, as different spatial narrative structure.

Janet Murrary also regards this relationship between advancement of space and narrative in parallel, as the players "Agency"(1 s. 162) in the game[9], detailing that: "*The maze is a roadmap*

[8] GRID is an acronym for "Guidelines for Rational Interaction Design"

[9] Actually what Murray attempts to design is not a 'Game' per se, but a "Cyber-drama". The difference between the two, when regarding the game as of the above mentioned genres, is inconsequential. Further discussion on this topic can be located in the

Error! Reference source not found., as to the debate between ludologists and narratologists.

for telling this story"(1 s. 130) therefore the narrative of the game is a participatory and goal-driven process for the player, as advancement through the level correlates advancement through space. In reverse, this allows an understanding of the player, that he will base his navigational choices, as much on the spatial cues he receives from the level, but also on narrative cues.

This argumentation thereby concludes that a level as a spatial structure will inform the players experience as a narrative, reconciling the two. It should be stressed however; that in reverse narrative is not limited to spatial constructs, but also exists, outside the level-design through many other means[10].

6.2 Level Design as a Bottom-up Process

The foundation of the GRID model is the inferential processes that the player is active in, while playing computer games. These processes are considered active, in the sense that the player is assumed to be in a constant process of observation and categorization of knowledge provided by the game. Fundamental to this, is the bottom-up processes that categorizes information, as outlined in chapter 3.1.1.

6.2.1 Informational Categorization

In physical reality, it can be argued that an individual could conceivably make his way to any location. It would similarly be a reasonable assumption that behind every wall, there is another place although it cannot be directly observed. In the virtual reality of levels in Computer Games, conventions dictate that this is by no means true. In fact, if a place is not observable – like the interior of a distant skyscraper, there it is most likely impossible to make enter that location.

As such, the player must identify the cues provided by the game, which indicates *paths* and *nodes* in order to navigate. This process entails following observations from the analysis chapter:

- Lynch's concept of paths, edges and nodes.
- Carson's use of contrasts of space and detail.
- Kabakov's strategy of placing strange objects that calls the attention of the visitor.

Due to the narrative spatial nature of Computer Games they often introduce several conventional oddities that go beyond roads and corridors as typical paths. It is not uncommon for a level to require that the player travels through an open sewer, or completely disregards doors as possible paths. Expanding upon this, it is a crucial ability for the player to identify barriers in contrast to obstacles that can be overcome at a later point in time.

- A *barrier* is similar to an edge, but perhaps best understood as a wall that indicates the player cannot pass, although it may appear to be paths further on. This is a typical issue when the game is set in large scale environments. Here a thin line of trees, or a door with no doorknob could indicate that passage is actually impossible.
- Like the barrier, the *obstacle* is a path that is unavailable, but in this instance the player will be able to overcome the obstacle at a later point in time. Chapter 5.4.3 notes how this is often used in The Maze structure (see also Figure 7: **The Maze**).

Different games have their own approaches when describing paths and nodes, which could be contextually depended, if the setting was very futuristic the player might have access to lifts and elevators, where a fantasy setting would not afford him such. This process of categorizing this

[10] Ie. Cut-scenes, character design, sound and so forth.

information is an inferential process, which applies previously gained knowledge from similar games and knowledge gained from the game itself. A player with a much experience within a given game genre or a contextual setting would be able to recognize navigable cues easier than others.

This informational categorization of navigable cues, informs the first schemata necessary to the player, wherein the conventional rules for navigation in the current game are solidified. Within the framework of this thesis, this schema enables the player to observe the game-world free of graphical elements and instead similar to the models presented in chapter 5.4.

6.2.2 Distinct Conceptualization

The process of informational categorization, allows the player to conceptualize the space in which he is situated. Recognized cues are organized in different categories by the player, both on a local and global scale.

- On the local scale, the player is able to identify distinct areas within the level. This may be thematically different segments, or it may be caused by the nature of challenges presented to him. The Lynch´s concept of *districts* are here enforced by notions of regular, hub and boss –type levels which was visited in chapter 5.3, each of these could be observed by the player as a particular district within the level.
  In a narrative parallel, thematically different areas could also serve as an argument for the player to conceptualize a distinct area of the level. Examples could be the experience of changing architecture in the level, or a difference in what paths and nodes that are encountered such as when the player is suddenly forced to navigate on the outside catwalks, surrounding the hotel which he had previously been inside.
- On a global scale, conceptualized districts can describe levels as a whole, against the complete selection of levels that are experienced in the game. The notion of the standard level, entails the argument that some levels will stand out, compared to the standard. Earlier referenced *Super Mario Bros.*(Nintendo, 1985) exemplifies this at an early point in history, where some levels would be cosmetically changed from the rest as “frozen” or “night-time” levels.

6.2.3 Constructing the mental model of space

This process results in a subjective schematization of the level, created and sustained by the player, which will be referred to as a “Mental Model of Space”. This model is inferred by the player, meaning that more or less importance can be connected to certain informational categorizations or districts between different players.

This entails two factors, to the process of constructing this mental model. Prior knowledge from other genre-related games or even physical-reality has impact on the development and of the mental model. Conventions within genres, especially those connected to informational cues, will also have a significant impact on the development of this model, as regular games might dismiss certain possibilities based on the knowledge of what other genre-related games have done. A more positive factor is that avid[11] or regular players within the chosen genre will show tendency for a faster learning curve when applying their previous knowledge of the genre.

The processes of conceptualization required for this mental model of space, argues for the validation of the second hypothesis (see chapter 5.5.2).

[11] Avid, regular and casual -gamers is understood as a measure referring to how much time players use of their free time on computer games.

6.3 Level Design as Top-Down Processes

The second part of the GRID model focus on the player's ability to navigation informed by the mental model of space. Similar to the items described above, these top-down processes are considered inferential and actively sustained by the player. It is important to note, that the players subjective understanding of space may be wrong, this factor however, will be touched up below.

6.3.1 Self position

Several factors, like starting point and a hypothetical end-point will be important to the player while building his understanding of the level, including the players own position therein. The players awareness of self and his imitate surroundings is a referential point to the model of space.

6.3.2 Sense of Direction

A characteristic for navigating the level will be for the player to establish an abstract sense of direction within the established mental model of space, which is consistent for the entire model. The sense of direction builds upon the information afforded to the player, such as:

- The starting point within the level
- The player's current position
- Information provided through hermeneutic coding, such as a foreshadowing of locations or actions
- Possible landmarks or districts already categorized

The sense of direction is therefore deduced in a top-down process in two cases:

- Referential points similar to the established cardinal points in reality. These are likely to be more or less complex depending on the elaboration by the player. In a fairly simple level design, where navigation is required infrequently, the deduced directions may be as simple as "left and right".
- A generalized direction of the level is a very abstract notion in physical reality, but since space in a computer-game is narrative, the player may be able to deduce what direction the narrative requires him to go. Landmark locations are equally applicable in this understanding of direction, but here a cut scene or an encounter of some sort, may serve as information for such a categorization.

Conclusion on top-down processes should include that these are processes that takes place in a situated model which is already constructed on inferences. As such, they are highly subjective and variables such as memory capabilities will have significant influences. Players are not considered flawless in their perception of space, and are subject to error-making. Wrongful assumptions of direction, will quickly lead to the sensation of being lost.

6.4 Level Design as a Parallel Process

The final third of the GRID model returns to the player's active state wherein he performs both bottom-up and top-down processes in parallel, to both apply and refine his mental model of space.

6.4.1 Path-making

Based on the information categorized into the mental model of space and the deductions performed thereon, the player navigates the world in a process of hypothesis making, and verification. This process of navigation in narrative/spatial structure shares characteristics with how Bordwell's Viewer is in a continual process of hypothesis making on the action of the film.

As an iterative process, the player will establish a hypothesis describing where, or to a lesser extend, which direction he needs to go in order to advance towards the next goal. This sense of direction will be deduced from the player's mental model of space, as well as the inferred directions within the map. While the mental model of space may be mainly build on navigational (spatial) information, strategies of narration may also inform this process. Examples gathered in this thesis include the concept of hermeneutic coding as well as narrators and guides exemplified through Kabakov's narrator[12] and Carsons "Following Saknussem"[13].

The process of path-making relates directly to the strategies of organizing information in schemes, which was visited in chapter 3.1.2 (see page 13). This process refines the player's mental model of space, as the hypothetical path is tested on the environment. If the path successfully leads the player forward, his mental model is verified as a strategy of *accentation*. New information about the model is assimilated as he proceeds forward, and as such the model becomes more detailed.

In a path-making situation a player is also likely to discover that a hypothesized route does not allow him to advance in the level. This may be due to two reasons. Either the mental model is wrong, in which case the player must *reconstruct* his model of space. The following process of reorganizing the information provided by the game may likely cause the player to backtrack through the world, to the last point where he could validate his understanding of space.

Another case where the path-making fails occurs when the level-design is made in such a way, that the player encounters obstacles which must be overcome or navigated around. Here the player is required to undergo a process of *tuning* his mental model of space, to encompass the new information.

In each of the three cases above, path-making through the narrative spatial-structure of the level, entails the strategies of assimilating new knowledge into already schematized information. The overall functionality of this is shown in Figure 12. Along with the top-down processes, this entails the 3rd hypotheses on path-making (see chapter 5.5.3).

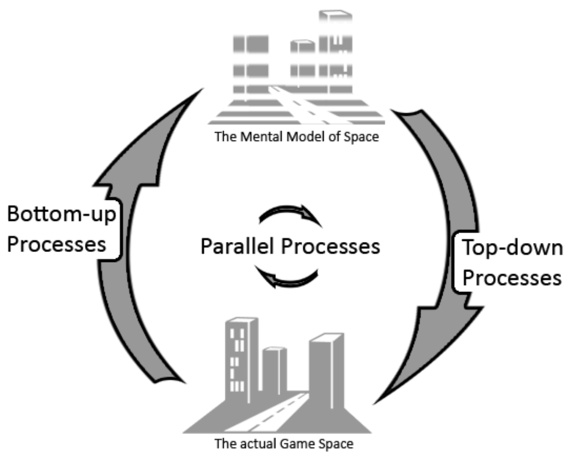


Figure 12: The cognitive processes of the GRID model

[12] See chapter 5.2.2 page 25.

[13] See chapter 5.2.1 page 24.

6.5 Conclusion

Based on the theory above, level design can be regarded as a dual process of designing an interactive structure, and providing the player with the necessary information to navigate this structure.

Designing the interactive structure entails consideration on how much content the player is to be presented with, and how much weight must be placed on the challenge of navigation. Understanding the player’s point of view, during the design process thereby allow the level-designer to embed information in the design that will aid or confuse the players understanding of space.

In conclusion, navigation is presented as a process of learning, similar under the functions of experimental cognitive psychology. The understanding of the player and the player's abilities to learn and navigate is put into focus, thus making for better games. It is therefore the assumption that these lessons applied to a game environment would allow the player perform navigational tasks faster or at least, with a higher degree of confidence. Surmising the GRID model, describes the Base Case hypotheses (see chapter 5.5.1).

7 Test Method

The GRID model unites the experiences of city-planers, artist and level-designers and more. On this basis, testing of the model is required, to verify that the cross-disciplinary lessons are actually compatible within the framework of level design. As such, this chapter will detail the method for testing, including:

- A prototype that must be developed as a platform for testing.
- An initial proof of concept that ensures later stages of testing to be conducted without losing data due to errors.
- A quantitative test that aims to answer the stated hypothesis.
- A qualitative test that verifies and elaborates on the findings of the second and main test.

It is the aim of this chapter to outline how testing will occur in a later stage of the project, to thoroughly integrate this process in the implementation of the prototype.

7.1 Low-resolution and High-resolution Environments

Because the GRID model relies on an understanding of how the player experiences the level, the test will be set between two conditions, a low-resolution and high-resolution environment, where the high-resolution environment applies the GRID model and the low-resolution does not.

The difficulty here lies in the construction of the low-resolution environment. At once, this level is supposed to be possible to navigate, so that the test results can be compared, while it should not apply the navigational cues that have been outlined during the analysis and discussion. Since these navigational cues have been gathered from a wide range of fields, it is safe to say, that anything that allows the player to actually navigate, even the appearance of a possible path, can be argued as a break from the "low resolution" concept.

To satisfy the dilemma, the design specifications for the low-resolution environment is formulated as such, that it utilizes the least possible narrative/spatial cues, while still providing the test subject with a world where navigation is plausible. The high-resolution environment optimizes the navigational cues through the GRID model and thereby, the difference between the two versions, will allow for good readings in the primary test.

7.2 Proof of Concept

This is the first stage of testing, here the aim is to optimize the prototype environment and avoid discarding tests, due to test-subjects possible inability to navigate the low-resolution environment. Additionally, this test will investigate if the questionnaire is comprehensible to the Danish speaking test-population, who have no prior knowledge about the nature of the project. Information gathered from this test will be based on observations on the test subjects during the test, as well as informal interviews after the test.

7.2.1 Demographics

This process will at first be based on observations made on selected subjects outside the desired demographics described below, who are students of Medialogy at the sixth semester. These students are currently studying game design, and as such, can provide well-informed observations on the prototype and questionnaire.

7.2.2 Expectations

It is expected that the test-subjects will point out flaws in the leveldesign which have been overlooked during the development phase. Some may also provide good inspiration for possible changes as well as identify their own preferences in level design. This process and its results will be described in Chapter 10.3.

7.3 Quantitative Testing

Due to the human centric approach of the GRID model, the majority of the test-data will be gathered via self-report, while the general performance of the test subjects can be measured objectively, through the length of time, it takes to navigate the test. This is the second and main stage of testing; here the aim to verify the stated hypotheses on the background of statistically significant differences between two low and high resolution conditions.

7.3.1 Objective testing

Hypothesis 1 establishes the base case for the GRID model, that the collected lessons it teaches will case the Player to perform more confident throughout the test environment. By applying an internal timing measurement of the prototype environment, the duration of the test can be measured, and from this, hypothesis 1 can be verified.

7.3.2 Questionnaire design

When designing a questionnaire for testing the players experience when testing the prototype research done on the concept of 'presence' builds a useful experience base. Witmer and Singer (26) develops in 1998 a questionnaire that seeks to measure the phenomenon of presence, whereby the user of a virtual reality environment, regards himself as "present" or situated within it. As a subjective experience that builds upon a mental state of mind, the effects of presence can be said to share characteristics with proposed processes of the GRID model. On this basis, the methodology proposed for the presence questionnaire, is transferred to the testing of the GRID model.

The presence questionnaire (PQ) divides the sensation of presence into several factors, which are assumed necessary for the phenomena to occur. These factors are then explored and divided into even lesser concepts which are discreet enough, to formulate a number of questions addressing these, when evaluating the experience the player have had in a virtual environment. Following the test, the subject then answers the given questions according to a Likert scale, which returns a numerical value between 1 and 5. The results of the questions, can then be used to evaluate both the factor, and sub-factor of users experience during the test. This process is illustrated in Figure 13 (page 40), here the bidirectional arrows connecting the factors with related sub-factors and questionnaire items, identify the data flow.

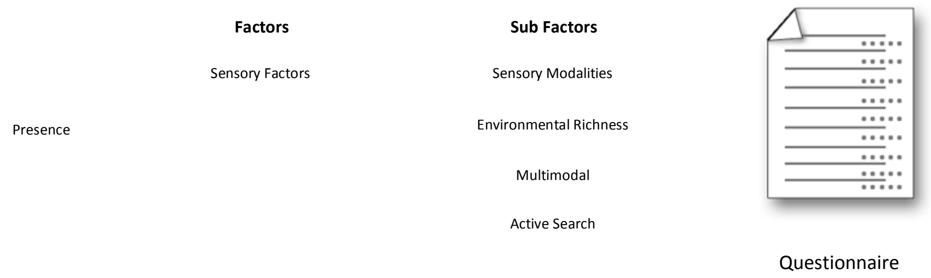


Figure 13: Functionality of the Presence Questionnaire

The power of this procedure is that it allows for a nuanced look on the reported user experience and it allows the designers of the test environment to empathize one factor of the test, by addressing more questions to that area. The downside is that the questionnaires include a vast number of questions, all of which can potentially confuse the test subject, or bore him. The later effect may lead the test subject to go faster through the questionnaire than needed.

Following the test, the high number of questions along with the complexity of factors and sub-factors, will also increase the time and effort assigned to the following data handling. Prior planning and a well designed questionnaire will make this process somewhat easier, and following the testing the factors may reveal unexpected trends within the test population.

7.3.3 Factors for testing

The GRID model is purposely divided into the three segments that answer the three hypotheses formulated on the background of the analysis. The final two among these segments contains functions that are maintained by the player, as he evaluates the level in which he is playing. This division can beneficially be applied as factors and sub-factors in a questionnaire on the players experience in the developed prototype. This division of topics is illustrated in Figure 14.

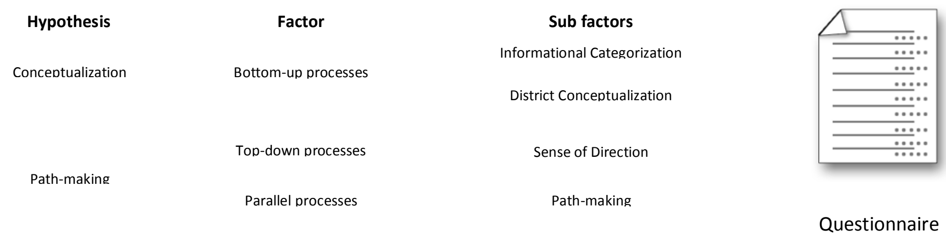


Figure 14: **Factors for the GRID model**

7.3.4 The problem with memory

Unlike the Presence Questionnaire which aims to measure the hypotheses of presence, the GRID model is tested on the background of two hypotheses, which, contrary to being a state of mind, is based on inferential processes which can be more or less elaborative.

Memory capacities can be expected to change from one test subject to the next, but generally, memory will become an issue when posing questions towards navigational challenges, which has come and passed.

In a situation where the test-subject is forced to answer on a 1-5 scale, where the lowest score disagrees with the question stated, and a high score agrees strongly, lacking memory may cause the test participant to rate low. This would be considered an error in some cases.

Another situation where the test subject finds his memory lacking, may cause him to perform elaborative inferences on the question, in order to provide an answer which is either what he believes is true to himself, or what would be beneficial to the test. Evaluations on how inferences are drawn, elaborate on this dilemma as stated in Cognitive Psychology: A student's guide "*Memory tests provide only an indirect measure of inferential processes. The potential problem is that any inferences found on a memory test may be made at the time of the test rather than during reading. In fact, may (or most inferences found on memory test reflect reconstructive processes occurring during retrieval.*" (3 s. 379).

To avoid these or similar situations, the self-report based questionnaire will be providing the test subject with a confidence test with regular intervals. The questionnaire will be divided into sections that deals with discreet locations in the level and each of these will open with an item asking "how well to you remember this location". This question is placed first specifically so that the test subject is forced to evaluate his own basis for answering the subsequent questions. Furthermore, carefully chosen reference material will be included for both test environments, which does not inform the test-subject about navigational aspects of the level, but reminds him of the specific location.

7.3.5 Demograpics

To provide a good statistical reading from the questionnaire, each of the two test conditions should have at least 30 test subjects. Considerations done regarding with regards to choosing the test audience were settled on two factors of importance, availability and knowledge of computer games. Since this thesis have been developed on the shared campus of the "Ingeniørhøjskolen i København - University Collage" (short-form: IHK) and Aalborg University Copenhagen, during 2008, a generalization of the available test subjects suggests a primarily male population between 20 to 30 years of age.

The ideal test persons have experience with computer games as players, contrary to being developers. They will have no or little difficulty engaging standard controls of an action adventure game. Their prior experience will also allow a degree of abstraction from elements that will not be included in the prototype, such as sophisticated AI agents that engage in combat and potentially defeat the player. In the later case, an analytic mindset engaged by an educated test-person would cause to direct attention towards specific parts of the implementation, contrary to experiencing the game, as the 'everyday' player would.

The qualified test person for the quantitative test is any student of IHK or Aalborg University Copenhagen, besides students from the sixth or higher semester of medialogy, due to their knowledge base of interactive systems. Students of the sixth semester will be included in the initial "proof of concept" test which is described above.

7.3.6 Expectations

As already mentioned Objective testing above under 'Objective testing', hypothesis 1 can be verified by applying the internal clock of the game environment. It is the expectation that the High resolution test subjects will perform faster than the low resolution environment, despite having to cover the same distance.

Regarding the remaining hypothesis, it is the expectation that these should prove significantly different, in that the High resolution environment provides a higher average that the low, which can be evaluated via the students T-test. Independent verification affords the best possibilities for an in-depth discussion on the testing results. However hypothesis 2 and 3 are logically linked through a presupposition that the process of path-making (hypothesis 3) requires a prior conceptualization of space (hypothesis 2). As per modus ponens, if the second hypothesis on conceptualization of space, cannot be validated, neither can the third hypothesis on path-making through space.

7.4 Triangulation of Test

The final stage of testing will be a qualitative test that will be conducted following the quantitative test. The aim of this test is to further verify the results already yielded and evaluate these.

7.4.1 Procedure

This test will run as a cross-test wherein test subjects play through one environment and answers the questionnaire, completely similar to how the quantitative test is conducted. Following this, the test participants will play through the alternative version of the prototype where they are now asked, to comment on their choices while playing. Finally, the test subject will be interviewed and given the possibility to elaborate on the experience of playing.

The tests will be conducted as Spanish-pairs, meaning that every other test person will play through the low-resolution environment first. Not only does this method equal the expectations the test subjects may have before engaging the second run, but also sets slightly different themes to the cross test. For the subjects that start with the high-resolution environment, the focus on the second run will be on “what is missing”, whereas the reverse procedure will emphasize how the GRID model informs the test subject.

The interview will ask into the mental processes of the player more directly than the questionnaire. As an interview, it is the goal to retrieve as much elaborative information as possible; therefore the test subjects will be asked what language they prefer answering in.

7.4.2 Demographics

The demographics for this test, is the same as in the quantitative test since the aim is for verification of the previous test populations answers. Narrowing in the demographics to completely exclude Medialogy students is done to eliminate any experience with game-design.

Additionally, the ideal candidates for this stage of testing, has a high level of abstraction, enabling them to “think out loud” with regards to their navigational efforts. Particular test subjects, who provide a good real-time evaluation of their considerations, will eliminate the above mentioned problem of memory.

Knowing that this testing would occur in a very limited time period, no actual number of required test subjects will be chosen, instead, it is the goal to retrieve as much information from these tests as possible.

7.4.3 Expectations

It is the expectations that this stage of testing will provide additional information as to why the results of the previous test, took the shape they did. The test subjects may weigh certain aspects in the navigation above others, which can indicate that not all informational cues from either cinematic or urban design are applicable. This is also expected to be a subjective difference between subjects.

7.5 Conclusion

The three stages of testing described above, outline the method for testing the GRID model and elaborate on the technical specifications. The first stage of testing is set to ensure that the subsequent tests generate the best data. The second stage is the primary test that collects quantitative data for answering the stated hypothesis and the final third stage of testing elaborates on these empirical findings.

Therefore such prototype will be developed which can play with either a high degree of informational cues, or a low. The prototype will log the test persons and provide for an objective analysis of how fast they complete the test, which will answer hypothesis 1. A questionnaire will be formulated that address the hypothesis 2 and 3 by inquiring towards the processes outlined in the GRID model.

8 Technical Specification

The following chapter deals with the requirements for implanting and testing the hypotheses presented in this thesis

8.1.1 The Basic Prototype Requirements

The requirements offered for the prototype are fairly simple, since the test is aimed at identifying mental activities of the player and not directed at development of a technical novelty.

- The prototype should appear similar to a contemporary computer game of the action adventure genre.
- It should not include any novel technology that could become a distraction to the tests, meaning that interaction with the game should be based on genre standards.
- The graphical requirements to the game world, is such that they depict a fictional world convincingly. The player should recognize the meaning of objects and their interrelationships.
- Playing the prototype should not exceed the capacity of the computers which the test will be run from. This means that the prototype should not exhibit erroneous signs like lag of response time or low frame rate.

8.1.2 Requirements of the low resolution environment

By implementing two separate conditions in the prototype, allows for the testing to proceed within subjects. The eventual values which are returned from the test can subsequently be compared with regards to what environment the test subject was under.

- A level must be developed that can be visualized with either low narrative-spatial information, or high spatial-narrative information.
- In both versions, the activities of the player must be observed objectively in such a way, that his navigational choices can be observed.
- The environment should include an initial safe-area where the player can become accustomed to the interface controls and – if need be, change personal settings such as mouse speed or control axis.
- The environment must be large enough for the player to experience it, meaning that the tests should last more than 2 minutes.
- Since the test is partly navigational, the test subject should have the possibility of choosing the wrong way when navigational aspects are investigated.
- The starting point and end point should be clearly marked, such that the player will know when the test has begun and when it is ended.

8.1.3 Additional requirements for the high resolution environment

In addition to the requirements for the low resolution environment, the high resolution condition should present the test subject with more information, as derived from the GRID model.

- This environment should specifically present a dilemma of Information Categorization.
- This environment should also include the possibility of district conceptualization by presenting thematic changes to the test subject.
- The high resolution environment should encourage the test subject to develop a sense of direction by using:
    - Landmark locations
    - An instance hermeneutic coding
- The high resolution environment should provide information for path-making.

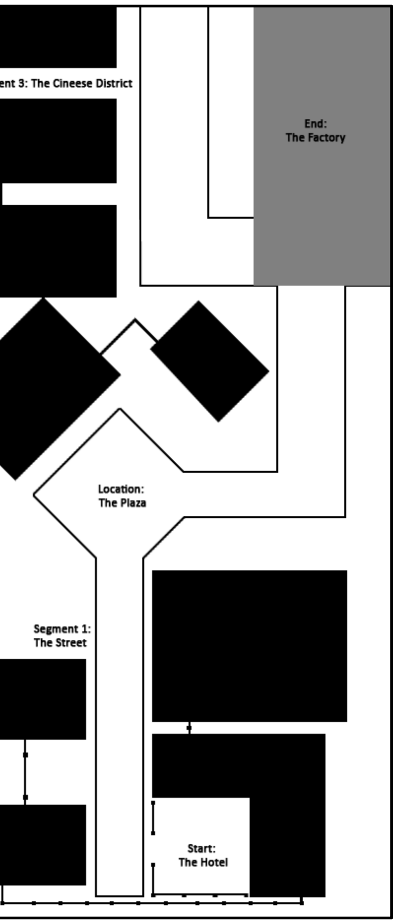
9 Design Specification

The specifications for the prototype development describe three segments which the player will pass through to complete the navigational task. The original design included only the first of these three segments, but as production began, it was evident that original design could be expanded and divided into three separate segments.

This would beneficially provide more difference to be experienced by the test subject, and especially return better readings in the case of district conceptualization (as part of hypothesis 2) and the time needed to complete the prototype (hypothesis 1). The down-side to the extended prototype development was the lack of prior planning, which resulted in a fairly simple third segment.

This chapter will proceed to reveal the details specific to this prototype, through the following sections:

- A section on the beginning and end locations details starting point and end for the test subjects.
- Segment 1: The streets; details the considerations for the first segment as an effort to direct the player's attention
- Segment 2: The Alley; details the considerations for the second segment as a complex spatial navigation
- Segment 3: The Chinese quarter; details design considerations of the third segment as recognizable spatial pattern



The final overhead design for these three segments, are illustrated in Figure 15. It is included here, for easy reference in the following sections.

9.1 Beginning and End Locations

The beginning and end of the level were important in the design process due to requirements posted for these as well as how they provide motivation for the player.

The initial location in the game is the hotel that leads out into segment 1. The Hotel is a simple brick building with a parking lot surrounded by a metal fence.

- The design for the parking lot should be large enough, that the player can freely roam around it. The internal timer of the prototypes logging mechanism should not start before the player exits the parking lot through a clearly designated gate. This will give the test subjects a chance to try out the controls before beginning the game.
- The hotel structure contains a sign that indicates it nature. With no other hotels in the prototype, this structure should remain recognizable for any test subject that gets lost.

The end location was designed to take the shape of a factory, on top of which, the player was offered an escape vehicle in the mission briefing. The requirements presented to the factory were fairly simply that the factory should be easily recognizable from a distance, since it would be applied as a measure of hermeneutic coding later. The ideal solution would be, to add a glowing sign to the front of the building.

9.1.1 Mission briefing

With the beginning and end locations settled, the mission briefing that is provided to the test subjects can be formulated. The mission briefing for the test subjects is that they are set out to locate the LRC factory. On the roof of this building there is an escape vehicle waiting for them, which will take them further in the game. Once the test subjects arrive at the vehicle, the game will take over the controls and the test subject will move on to answer the questionnaire.

9.2 Segment 1: The Streets

The first segment in the prototype aims concisely at creating two specific situations and establishing a thematic understanding of the segment itself.

- Firstly, the progression of the test subject through this area leads directly to a location where the LRC sign on the factory will be glowing.
- Secondly, the player is presented with two doors and two roads from the plaza, where he can observe the factory's LRC sign.

As with the first act of a narrative, it is the clear aim to establish the player's direction for the remainder of the level, during this segment. Similarly, it is understood, that future additions to the players mental model of space, will be evaluated on what is presented in this segment.

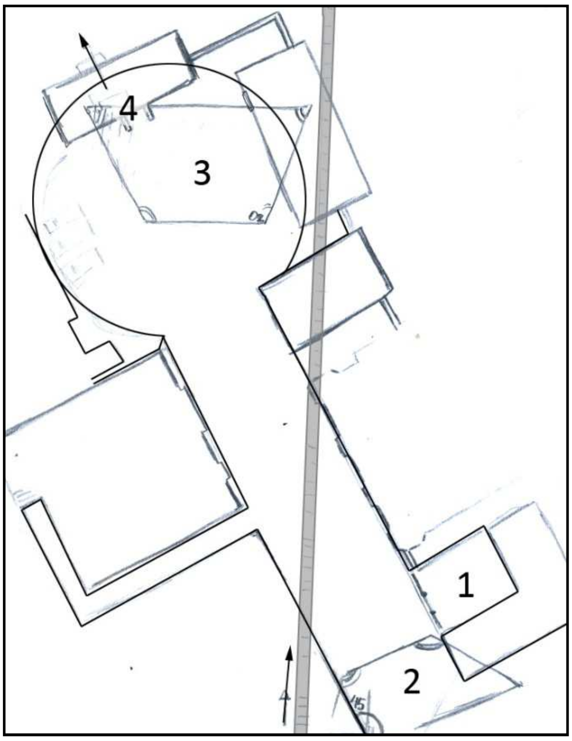


Figure 16: Design sketch for Segment 1 of the Prototype

Figure 16 illustrates the initial draft for the first segment of the prototype. The points included are as follows:

1) The Hotel where the test subject beings the test.
2) With emphasis on the streets and the sky rail that will be implemented in the high resolution environment, this marker provides the point of view that is required for Figure 19 (see page 50)
3) As above, this notation marks the location, which will be referred to as "the plaza" that provides the point of view illustrated in Figure 17 (see page 48).
4) This location points to the building (building G) that provided the possible progress to segment 2.

9.2.1 Establishing Theme and Direction

The first segment introduces a complex situation to the level design, where the test subject is presented with no initial direction while in a navigational challenge. It is very conceivable that a test person could wander aimlessly around for a while, if measures were not taken, to establish a general direction early on. To overcome this design challenge, two recourses could be engaged. The number of alternative paths could be limited, and the player could be provided with guiding informational cues.

The informational cues selected, are streets for the first segments, which are semantic analogs for paths and as such, should be easily understood by the test subject. Measures were taken to give the street a "wide" feel, to underline its importance as a path with the test subject. To accomplish this, the first segment of the world is build out of scale (roughly 1:1,6) where the buildings are too large for the player which makes the streets consistently too wide.

With the street and outdoor environment being very open, the street segment aims to build a thematic contrast to the second segment of the level, where the test subjects will advance through a denser segment.

9.2.2 Directing focus to the LRC sign

As already mentioned, the LRC sign is an intended landmark embedded in the factory building which constitutes the goal for the test subject. To guide the test subject to a position where the LRC sign is clearly visible in the distance within the framework of the already established streets, the orientation of the buildings were applied.

Figure 15 (page 45), contrary to the earlier draft shown in Figure 16(page 46), illustrates how the buildings in the first segment are oriented orthogonal towards the street, until the player reaches the plaza. Here the two buildings that are placed directly at the end of the street are turned in a 45 degree angle. This is the application of contrast to the already established, environment. The intended result is shown in Figure 17, where the two buildings almost converges, but leaves a little space between them, so that the player can observe what is behind the buildings which is where the LRC sign should be placed.

The information provided by the location of the LRC sign is an important factor for both the top-down processes of sustaining a sense of direction and attempts at path-making.

9.2.3 The Two Doors

As also shown in Figure 17, the plaza suggests a future location for the test, but introduces a barricade to this, as a fence blocks the path. This is set up in order to test if the test subject begins formulating a path towards the goal.

The design here, is aimed at presenting two possible doors for the player to follow, of which only one can be opened and let him progress through segment 2, as a detour towards the factory. To futher empahtise that, contrary to following only roads as paths, doors are also a possiblitiy, the buildings presented at the end of the plaza, is now in a 1:1 size with the player.

The choice of what door the player attempts to enter first, is informed with significant difference between the high and low resolution enviorntments. In the low resolution enviornment, both doors are equally represented with lights and surronding detail level.

In the high resolution enviornment however, the correct door is surrounded with additional lights, and a gate like structure. Because it will of indirect interst to the hypothesis which of the doors are approached first, as it is a meassure of information catagorization wehter or not the player identifies the gate as a navigational cue, checkpoints should be placed before each of the doors.

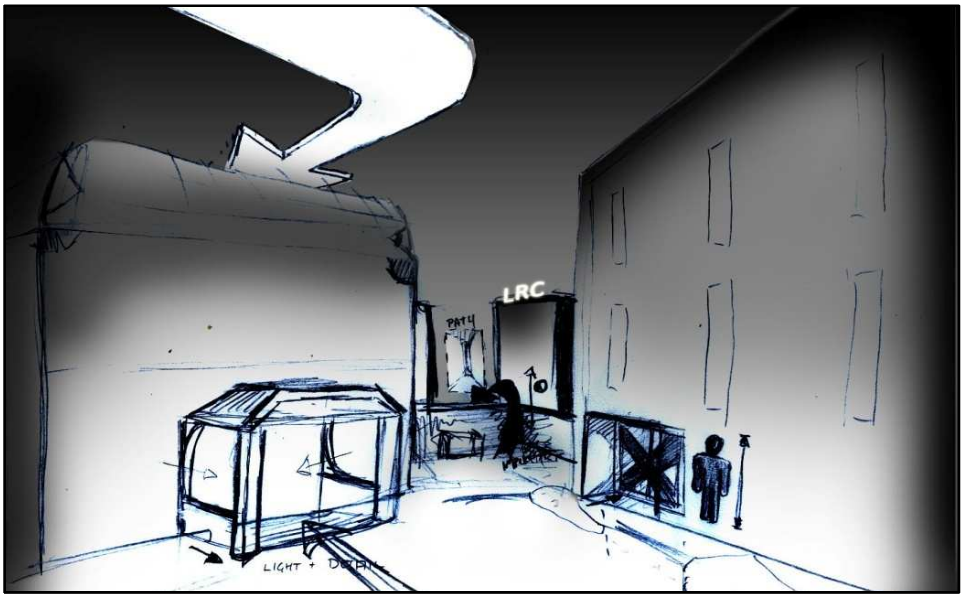


Figure 17: Design sketch for the hermeneutic coding in segment 1

9.3 Segment 2: The Alleys

The design for the second segment in the prototype is a part of the level that is different from the first part in several distinct ways. This is implemented because the test subject is now informed about the location of the LRC building, and is most likely attempting to locate the fastest route to it. This section will cover considerations done with regards to:

- Space as an obstacle
- Application of the gate

Figure 18 shows the final sketch for this environment. The sketch is drawn upon a set of spatial primitives that constitutes buildings, which was printed out from a screen capture of the available space. The added detail thus 'fills in' the space available in the level. The markings in the figure are explained as follows:

1) The point of entry. This is where the player emerges after passing through segment 1.

2) This location marks a significant choice for the player, presenting the possibility of either passing through the tunnel first, or proceeding to take the stairs up.
3) After taking a lift up to the third floor, a cat walk allows access to a control panel. Here the player can open the gate which is directly below the switch.
4) This marker indicates the location of the gate. The player will not be able to proceed forward before he activates the switch in location 3.

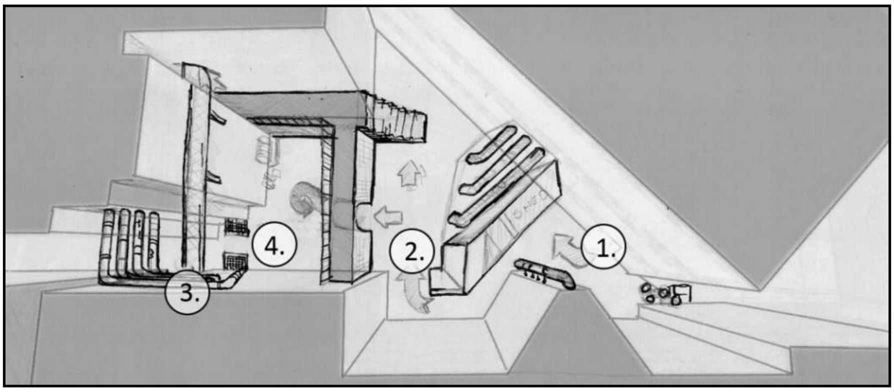


Figure 18: Initial design sketch for the alleys in segment 2

9.3.1 Space as an Obstacle

The gate and switch situation exemplifies the maze structure as one of the common models of interactivity (see chapter 5.4 page 28). Whether the test subject chooses to go up the stairs and activate the switch or proceed through the tunnel and be forced to turn around when he encounters the closed gate, the player is forced to re-evaluate his chosen course. This evaluation will be important for the questionnaire, as it will investigate the process of path-making.

9.3.2 Application of the Gate

The gate requires that the player takes the lift up. In the high resolution environment, this means that the player is located directly beneath the sky-rail, which will be detailed later. The nature of the thematic of the second segment is that all paths are close and narrow around the player. As such, the player in the high-resolution environment will not be able to reference the sky-rail as a landmark, but once he goes up, this cue is provided very close to him. Presenting this information to the test subject, should result in a better reading when testing on factors that are related to the player's mental model of space.

9.4 Segment 3: The Chinese Quarter

Originally, the last third of the prototype was originally intended to exemplify a short segment of China Town, which was described as a narrow street with small shops reaching out from every building. The application of more street based navigation seemed somewhat redundant, which lead to the application of a recognizable spatial pattern. The final segment of the prototype is constituted by a small collection of buildings that are organized around a center courtyard. The Chinese theme of the buildings is kept as a part of the implementation.

Additionally, the high resolution environment will be directed to go up another lift before entering this area, from here the test subjects can gain an overview of the courtyard before proceeding onwards. This overview also provides information for the path making of the player.

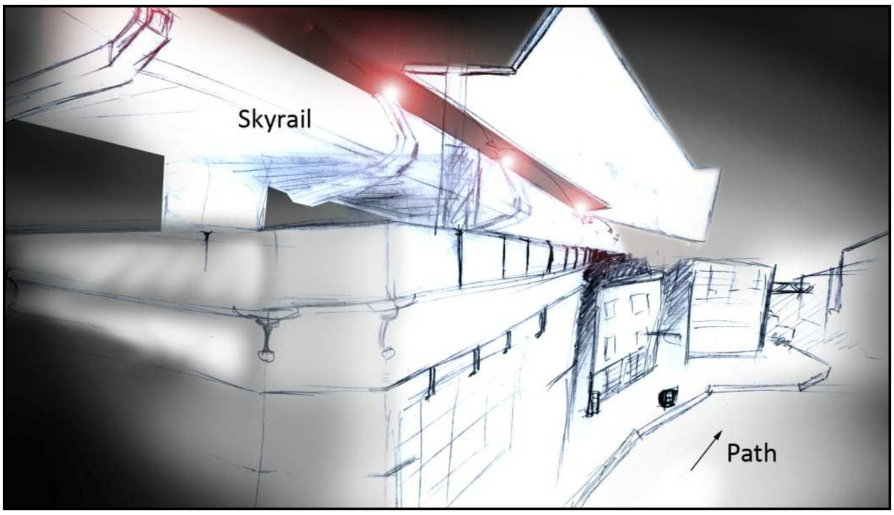


Figure 19: Design sketch for the 'Sky Rail' as a constant landmark

9.5 The Sky Rail

A crucial addition to the high resolution environment is the sky-rail that stretches across the entire level in a straight. As shown in Figure 19, the sky-rail is a train track running above the buildings, beginning at the hotel, passing over the alleys and continuing past the factory.

The sky-rail is a design goal that has been implemented to create a common point for the high resolution test persons to reference at most times while they are navigating the level.

9.6 Discarded Narrative

In the initial design phase, a narrative was drawn up to support the action in the game. Herein the player should take the role of an assassin which mission begins at the hotel, where he sets out to first locate a hidden sniper rifle as an embedded waypoint, and then proceed to take a vantage point from which he can assassinate his target. This should be a fairly simple AI that could be taken down with a single shot. Additional considerations were made towards developing a subsequent escape route, in order to get the most reusability out of the developed prototype.

The overall narrative was discarded due to the collaboration with fellow student Henrik Bjørkå, whose object of attention during the test, was directly focused on the health-level of the player compared to what information the player was presented with during the game. As such, any kind of action that could hurt the player could potentially spoil his readings.

9.7 Sub-Conclusion

Expanding the prototype into three individual segments, with each their own theme and identity is indented to provide variation within the level, that should successfully provide good readings between the high and low resolution environments.

A final level graph has been developed for the implementation, which is in accordance with the models of interactivity from chapter 5.4. this is included in Appendix F.

10 Implementation

This chapter details the process of developing a prototype game environment that can serve as a platform for testing the hypothesis proposed through the GRID model.

The prototype will be developed as a collaborate effort, such that it supports the parallel testing of Henrik Bjørkå's 2008 master thesis "Indexical feedback and player-avatar agency Conventional HUD feedback vs. Indexical Feedback" (27).

- This chapter will first look into the choice of game engine as development platform. (lot of content, little time)
- What follows is a section that details the realization of the design specifications with regards to the individual segments of the prototype.
- After this follows a section that formulates the items in the questionnaire which will later be used to validate the hypotheses.
- Finally a section details the proof of concept test that was conducted, to verify that the prototype would function and the test could be conducted. These findings are presented here along with the alterations they caused.

10.1 Choice of development platform

The technical specification does not propose any concrete specifications towards which development platform should be applied for the implementation of the prototype. This is caused by the orientation of this thesis as mainly focused on the players experience of the game. As such, most game engines within a five year range would suffice for creating an environment with embedded narrative and spatial cues to guide the player.

The choice then comes down to three factors; Availability, Approachability and relevance to the market.

Availability for game engines is quite high. Aalborg University Copenhagen is already making a number of Dassault Systèmes' Virtools licenses available for the student population. At the same time, it has been a long convention for developers to include the game engine or a level editor on the DVD of popular games. As such, *Half-life 2*[Valve Coporation, 2004] with the Source Engine[Valve Coporation, 2004] and *Unreal Tournament III*[Epic Games, 2007] with the Unreal 3 Editor were also readily available choices.

When presented with issues of approachability of the development tool, The Unreal 3 Editor was easily identified with the most tutorials that were readily available. Besides a healthy online community similar to that of the Source Engine, Unreal Tournament III as the Collectors Ediiton, ships with 20 hours of tutorials.

In issues of relevance, the choice is again left to either the Unreal editor or the Source engine. From an immediate point of view, Virtools has a board focus that allows the development of many different games and game genres. Both the Source Engine and the Unreal Editor delivers packages that are aimed at creating 3D games.

The final choice for an implementation environment falls on the Unreal Editor, mainly due to the 20 hours of lessons that are made available. The game engine also holds a slightly higher relevance to the industry as it is newer, and therefore, more worth the investment of time it takes to learn how the application functions.

10.2 Implementation of the prototype

This section of the implementation chapter covers the development of the requirements that were surmised and formalized in the design specification. At certain points during the implementation, some areas were elaborated on, either for coherency in the level or to advance the goals of the implementation. Where such steps were taken, it is duly noted.

10.2.1 Implementation of the Hotel

The design specification provided little information on what was required of the hotel. It should include a hotel sign, parking lot with enough space to become accustomed to the interface and a fence with a gate. The final hotel can be seen in Figure 20.

Figure 20: The Hotel

Since this was the starting location, where the player would initially be facing the wall, a number of cars were added as decorations. These were however put to use as an indicator, if the test conditions was changed to a high resolution environment, an additional white car would appear in the far end of the parking lot. This car became a good indicator for those conducting the test, that the command to load the high resolution environment had been given correctly.

10.2.2 Implementation of the Factory

As shown in Figure 21: **The LRC factory**, the factory was implemented with a large orange sign spelling LRC. The sign was selected from the Unreal Editors library of pre-generated content, due its clear visibility. Furthermore, the blue sky in the background was chosen as a contrast to the sign. Because the sign had to be visible from a significant distance, it was placed fairly high on the building.

Figure 21: The LRC factory

10.2.3 Implementation of Segment 1

The design specification for the streets provides adequate information for the implementation to occur. Several alleys and niches between buildings were included to embed a more realistic image of the city, although these were all cut short and provided not secret areas.

The usage of light posts

Light posts were added below the LRC sign to inform the test subject that the road continued on the other side of the fence that follows the plaza (as visible in Figure 21). These were similar models to those that lined the previously visited street and actually aligned with those as well(as visible in Figure 20). The strategy here, is to apply the information categorization already adapted by the player as functional hermeneutic coding, informing him that while access to this area isn't directly available, it is a location he can possibly visit through a different route. It was similarly a design choice not to include these light posts in the dead-end road that leaves the plaza. Since this was a dead end.

High and low resolution versions of the plaza

As described in the design specification, the plaza is modified by a gate that is added to the door of one building. From a distance, this actually makes the door itself more difficult to spot, due to the obstructing building materials. Based on the GRID model, the structure of the gate references prior knowledge of the player, that the gate contains a door. The additional geometry, and light, should clearly signify the door as a possible path for the player, especially in contrast to the other door on the adjacent. As a test for the process of information categorization, a check box were placed on both doors, allowing for recognition of which door was attempted opened first.

In the high resolution environment, a statue was placed in the center of the plaza. This was done to further signify this site, as a specific location. At a later point of the test, the questionnaire would enquire to towards this, as a part of the conceptualization of space. These changes are illustrated in Figure 22 and Figure 23.

Figure 22: Segment 1 (Low resolution)

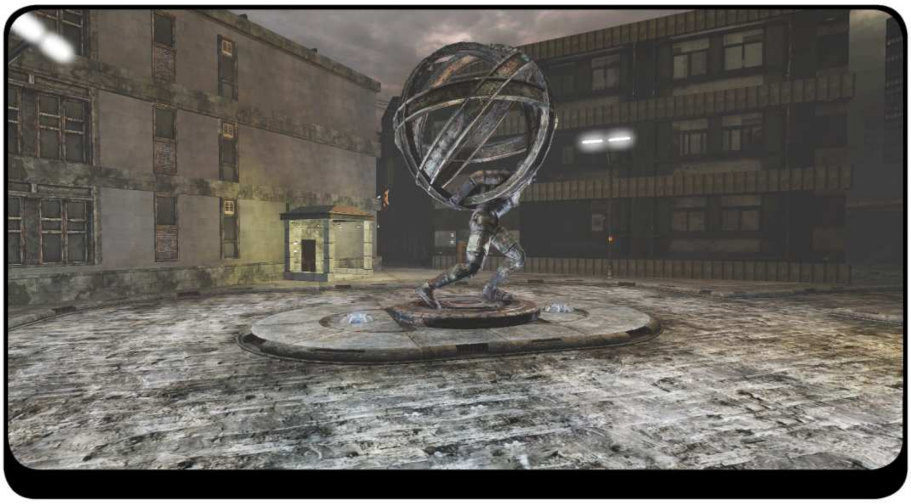


Figure 23: Segment 1 (high resolution)

10.2.4 Implementation of Segment 2

The alleys were implemented with spatial navigation, being a challenge to the player. This was done by excluding the player from having a long look forward at any time, except the one crucial point from where both the stairs and the tunnel is possible. This point is located as mark number 1 in Figure 18 (page 49).

High and low resolution versions of the alleys

Cues are placed alleys are set up to inspire the test subject to enter the tunnel before taking the stairs. The reasons for doing this, has been to inform the test subject of the gate as a barrier (location 4 in Figure 18, page 49) and will be able to connect this, with the rolling mechanical sound that plays out when the switch is activated above.

As also mentioned in the design specifications for the second segment, upon taking the lift up during the high resolution environment, the player is located only a little bit beneath the sky-rail, which allows him to verify his position according to his mental model of space.

Figure 24: The Alley

10.2.5 Implementation of Segment 3

The Chinese Quarter was implemented as a lowered location, as shown in Figure 25, with added fog to inspire the atmosphere of the location. There were two ways of proceeding through this level, either by walking through a corridor of one house, or following a path around the buildings.

High and low resolution environments

The difference between the high and the low resolution area in this segment is a detour taken by in the high resolution environment that allows the test subject to gain an overview of the Chinese district, before he enters the area. Through this the player is provided a vista similar to what is shown in Illustration 14 (see page 88).

This is a feature that is intended to provide information for the test subject, to make a hypothesis on his further advancement in the level. Contrary to this, the Low Resolution environment does not offer this vista.

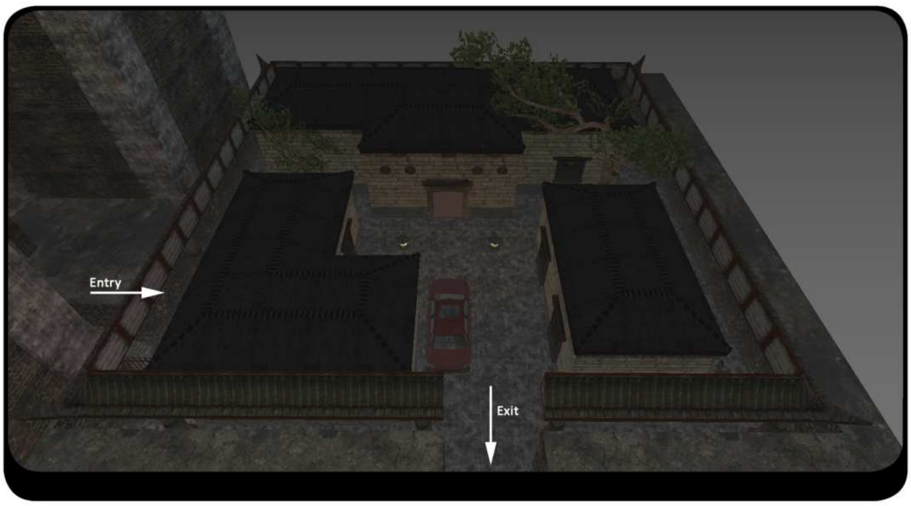


Figure 25: The Chinese Quarter

10.3 Formulating Questionnaire Items

This section finalizes the questionnaire according to the requirements that were posted for it in chapter 7.3.2 (see page 40).

The questionnaire will be divided into five different parts, where each part asks towards its specific area of interest. The first asks towards demographics, while the remaining asks towards the three specific segments of the test environment and the fifth address the overall navigation process during the test.

As described in chapter 7.3.3 the test questionnaire will be divided into factors answering each of the two hypotheses that will be tested by self-report. The factors that questions will be addressed towards in the questionnaire, will be directly derived from the processes that constitutes the GRID model (see chapter 6). Hypothesis 2: Conceptualization will be addressed by the sub-factors of information categorization and district conceptualization as well as identification of landmarks in the level. Hypothesis 3: Path-making will be addressed by the two sub-factors named 'Sense of Direction' and path-making.

Also, as described in chapter 7.3.4 (page 41), each of the three location specific parts of the questionnaire begins with a confidence test. This is implemented to ensure that the test subject remains self-reflective. Following this all questions of the questionnaire will be answered in a five point likert scale, where 5 is high, with the additional option of reporting a "don't know" in which case the answer is null.

Following the fifth and final part of this questionnaire, comes a final part that addresses the test performed by Henrik Bjørkå, as part of his master thesis (27).

The questions are lettered and numbered to indicate which part of test they belong to. A relates to demographics, B relates to this thesis and questions that are presented under the letter C are formulated with regards to Henrik Bjørkå's thesis. The final questionnaire is included as Appendix H

10.3.1 Demographics

The initial part of the questionnaire clarifies the demographics of the test person. Routine questions are asked towards age and occupation to insure that the test person is within the chosen demographic for the test. The test subject is also asked towards gaming activities in the following:

A03	How many hours do you spend playing computer games a week
A04	In this question, the player is asked to rank his three favorite genres in computer games, where 3 rank high.
A05	How confident are you in action and adventure games

10.3.2 Questions regarding Informational Categorization

These questions ask about the simplest degree informational cues as a bottom-up processes (see chapter 6.2.1 page 34).

A02	How much did you use light and dark areas as part of your navigation?
A03	Did you recognize the doors as possible paths?
A04	Did you recognize the roads as possible paths?
A11	Did different colors of light help you navigate through this part of the level?
A19	Location 3 is build around a fairly simple notion of a "courtyard" while playing, to what extend did you recognize it as such?

A23 Did the objects in the world seem natural to your understanding of the world?

In the questions above, item B19 and B23 stand out because they ask whether the test subject applies prior established knowledge in his categorization of information within the level. This could easily have been expanded with a question towards streets lights relationship to roads and vice versa.

10.3.3 Questions regarding District Conceptualization

These questions address the conceptualization of space, to investigate if the test subject is sustaining a mental model of the space he is located (See chapter 6.2.2 page 35).

A10 Do you recall recognizing a thematic change in the environment?
A14 This location uses very narrow paths, how much did this affect you?
A15 This location introduces lifts, which takes you high above ground. How much did this affect you?
A17 Do you recall recognizing a thematic change in the environment?

The reason that neither of these questions addresses the first segment, is simply that during this part of the level, the test subject have not yet experienced any significant differences that would qualify as a thematic change.

10.3.4 Questions regarding the identification of landmarks

Special interest is aimed at the player's attention towards landmark locations throughout the prototype. The factor itself is in the GRID model, included in the process informational categorization and important to the construction of the mental model, especially regarding the players sense of direction.

A06 Did you identify the 'plaza' as a specific location?
A24 How much did you notice special locations that you could use for navigation through the entire level?

Question A24 is extended with a line for test subjects to point out which landmarks they used themselves.

10.3.5 Questions regarding the test subjects sense of direction

These questions address the test subjects established sense of direction (see chapter 6.3.2 page 36).

A08 To what extend did you feel confident that you were going the right way?
A13 Passing through this area confused you, regarding sense of direction?
A18 Passing through this area, did your sense of direction increase?

10.3.6 Questions regarding the test subjects path-making

The questions below ask specifically to the process involved with path-making as the test subject navigates the level.

A07 To what extend did you observe possible paths which you did not take?
A20 How confident are you, that you could take a shortcut to this area from the hotel, in a larger implementation?
A22 Are you currently confident you could make your way back to the hotel from the Factory?
A25 To what extend did you feel lost while playing through the level?

10.3.7 Sub-conclusion

The completed questionnaire asks indirectly as well as directly to the five factors derived from the GRID model. These factors are divided into two result groups that will answer if hypothesis 2 and 3 can be validated.

10.4 Proof of Concept Test

The final production phase included a concept test aimed at verifying the usability of the product. Information gathered here, targeted design errors that would either pollute the test.

The aim of the initial testing, was to streamline the test setup in such a way, that all test subjects would perform on 'common ground', meaning that the low-resolution test population would have a chance at completing the course without the test lasting beyond the expected 20 to 30 minutes in total. Demographics for the initial test were chosen to be among medialogy students of the sixth semester. At this particular semester, they provide some *knowledge* of computer games which they have not yet applied, and prior application based experience with film theory. As such their rankings were discarded for the testing of the hypothesis, but they provided valuable insights into the functionality of the product.

Quantitative testing with med 6 students was done, where their navigation was closely observed. Among these students a qualitative interview with Jon Ram Pedersen was conducted, where the test participant was asked to voice his thoughts concerning the game environment.

10.4.1 Observations on segment 1

Segment 1 included two doors on the sides of the buildings adjacent to the streets that generally brought confusion in both test environments.

This is explainable within the context of information conceptualization. As the player would recognize doors as paths, but when being denied on several attempts, he is likely to make the inference that the game does not support does as viable paths.

To solve this problem several steps were taken:

- All unused doors were deleted
- Additional pair lights were assigned to doors in at the plaza, so they would be clearly visible in both environments.
- Additional width was given to the borders around these doors.

10.4.2 Observations on segment 2

Test subjects had difficulties understanding and navigating Alleys. This was an expected consequence of providing a challenge in an environment that previously had no similar challenges. To provide better information about the different areas in the environment, the following modifications were made.

- Elevator lights running up the wall were moved into a central in-frame position, when observing the elevator lift. This gives a clearer picture of the functionality of the elevator lift, even from a short distance.
- A light source was moved to cast light out though the tunnel which makes it possible to deduct that there are items on the other side of the tunnel.
- Color coded lights were used to further inform the player of his position within the alley. Elevator shaft and surrounding area were given a blue light, while the tunnel and

the small area between it and the gate were colored red. The remaining parts of the alleys were kept in brown and grey colors.

- The sound cue playing out when the gate switch was also changed to a louder and more mechanical sound. The original implementation had used the same sound as the elevator lifts do.

10.4.3 Additional points of notice

- One student indicated that the chosen ambient music playing in the test room (low volume, “DR Electronica” net radio) was a good reference point for questionnaire item A07. “Were you aware of event occurring in the real world around you during the game?” Since the point of audition emanates from outside the test environment and although there isn’t any ambient music playing in the prototype, this is actually a mild distracter.
  It was agreed that it would be a good indicator for players relating to the specific question, and a favorably chosen ambient for the test procedures. The actual result was therefore, that the sound volume was turned up slightly.
- It was noticeable that some test subjects reacted to the game differently when the game was introduced as either a “mod of the unreal engine” or “a prototype action adventure game”. Because games of the *Unreal Tournament* [GT interactive, 1999] -series are strictly action games that deals with fast paced combat, this introduction could be counted as a distracter for the test proceedings. These players approached the game differently, including one player who was frequently jumping, to avoid sneak attacks by the (imaginary) adversaries.

The above corrections allows for the prototype to adequately support testing in the qualitative test. While most corrections were of a minor nature, the identification of the doors as a distracter made an important difference to the prototype.

10.5 Sub-conclusion

A prototype game environment has been developed with a recognizable start and end location. In between, the test subject must proceed through three thematically different segments, each with its noteworthy locations. This universe has been build so that it can be changed through a high and low resolution version by adding a simple command to the command prompt.

The prototype applies lessons learned from the GRID model, and a questionnaire has been formulated to investigate if the test subject behaves as is the expectation of the GRID model.

The prototype includes two insignificant errors which has not corrected:

- This is a pair of gloves, floating beneath the player as a result of having his weapon removed. The gloves are only visible in cases when the player is looking directly downwards. They are therefore evaluated as inconsequential to the testing.
- Secondly, none of the included cars have object collision, which means that the player can walk through them as though they do not exist. The cars are only included as decorations and serve to establish an understanding of the level as a populated city. The cars could have been removed, but were not, as it was decided that their presence in the game world added to its realism.

An actual flaw in the design, which was discovered during the process of data handling, is the detour which the high resolution environment forces the user on. As mentioned above in chapter 10.2.5 (see page 55), the player must take a slightly different path through the final part of the alley where he is afforded an overview of the final third segment. This detour makes a temporal comparison in this area invalid.

If the following test yields a significant difference between the two environments, both regarding the speed it takes to finish and the reports the test subject provides to the factors of the questionnaire, then this prototype will have allowed the hypotheses to be validated.

11 Test

This chapter details the testing and verification of the factors within the GRID model. The chapter describes the tests as follows.

- The first part of this test investigates the second and main stage of testing.
    - The first section described the test procedure, from the briefing and to the debriefing of the test subjects.
    - The next section presents the results gathered in from the quantitative test in an objective manner.
    - Finally follows a discussion on the background of this data as well as all previously researched data. This section describes what will be of interest in the third stage of testing.
- The other half of this chapter goes into detail with the third stage of testing, which is a qualitative interview based test.
    - The first section describes how the test procedure was elaborated on, to provide more feedback.
    - Then follows a chapter that describes observations from the test, as objectively as possible.
    - Finally a discussion surmises the important data in this chapter

11.1 Test procedure [qualitative testing]

The test procedure was conducted with focus on processing many test-persons in a short time, without polluting the test subjects. It has been the aim for the testing to include a test population of at least 30 subjects for each condition, in the quantitative testing.

11.1.1 Setup

A lab was reserved for the testing to take place. The test environment was set up so two test subjects could be testing at the same time, while two additional subjects could be filling out the questionnaires. To accomplish this, the lab was set up, as illustrated in Figure 26 (see page Figure 26).

The agenda for each test consisted of the following steps:

- Briefing
- Playing the prototype
- Answering the questionnaire
- Debriefing

Briefing

Upon being welcomed to the test environment the test subjects were given a briefing about what was going to happen. Test subjects were informed that they were participating in the joint testing of two master students. They were informed that the test would be very human centric, meaning that the prototype that they would soon be playing was not as much the product itself, as their experience of the game environment, which they would subsequently be asked to report in a questionnaire.

After this, the test subjects were informed about the prototype; that what was developed here was a prototype action/adventure game – similar to those they would play at home, but with some parts left out. The test subjects were then informed that they would not encounter any enemies in the level, but that they could expect all other sort of challenges. Specific mention of the lacking enemies, were made in response to the proof of concept test, described in the implementation chapter (see chapter 10.4.3 page 59), so test subjects did not divert their attention to the threat of attack.

Finally the briefing informed the test subjects of the two flaws in the environment. Making it a point to show the test subject the floating arms, were done to avert confusion later. Finally, the test subjects were asked to sit down by the computers and told that when they felt ready, to proceed through the gates of the parking lot and into the world. The test subjects were shown their mission briefing on the wall next to them and told that once they left the premise of the hotel, the internal timer of the game would start and the game would begin to log their activities.

After the briefing, there were very few test persons who had any questions.

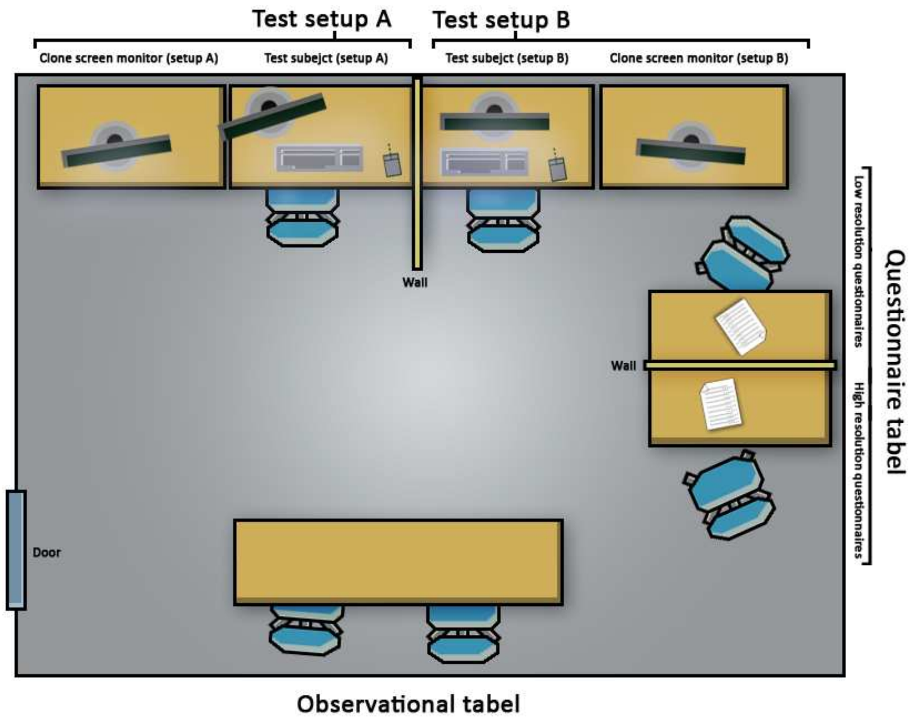


Figure 26: Test Setup

Playing the prototype
Two computers were running the test prototype which were classified as test machine A and B. In general, machine A was running the high resolution environment while machine B was running the low resolution version.

Both computers were set up with a two screen output, which was configured as clones. The clone screen was moved away the computer to a point where they were visible for those conducting the test. This made it easy to keep track of both test subjects at the same time, so that they could be helped if problems arose.

Additionally, both test machines were separated by a thin wall and both test subjects were wearing headphones, so not to disturb each other. On both sides of the wall, a print of the factory (the end point for this test) and the escape vehicle (the end point for the second test conducted by Bjørkå (27)). Test subjects were allowed to reference these prints in the same

manner as some games provide a mission briefing. This would ensure that the test subjects recognized the factory when they saw it.

Questionnaire
Once the playing through the prototype is done, the test subjects were moved to a different area of the test environment, where they could fill out the provided questionnaire. Although the questionnaire is the same for both test conditions the game world which the questionnaire references is not. For each of the parts where the questionnaire refers to a new segment in the prototype, it simultaneously refers to an image of that location. Despite these images being kept with as little informational content as possible, there were key differences between the two test conditions. As such, a wall was set up between two tables each with their own three images from the prototype.

Debriefing
After the test had been completed, the test subjects were shown to the door and asked for any follow up questions. Where time allowed it, short discussions and talks about the content were indulged. Observations from these talks were not documented since the primary purpose was to leave the test subject with good feeling about the test, since most were already in a hurry with their own work.

Systems specifications
Both computers running the test environment had the same specifications.

- Intel Quadcore 2,1Ghz
- Nvidia 8600 GT, 521mb dedicated RAM
- 4GB RAM
- Headphones for sound
- Dual screen output to two screens running a resolution of 1680x1050

With regards to the particular software the prototype was implemented with, the hardware on both machines were more than adequate and showed only very few signs of systems lag.

11.2 Quantitative Results
63 students participated in the quantitative test. The dominant part of the test subjects were found among volunteer medialogy students between the 2nd and 4th semester. The average age was around 24, while students as young as 18 participated and a single as old as 39.

The tests were all completed except one, where the test subject was discarded due to a complete inability to control the environment. After he reported suffering from dizziness the test was immediately cancelled. It is unknown what factors brought on this dizziness.

11.2.1 Results regarding hypothesis 1: Base Case

The first hypothesis, as described in chapter 5.5.1 (page 31) states that: *"An environment, richly detailed with narrative/spatial information presented in analysis, will yield a better navigational performance from the test subject."*

This logically entails that high resolution test person should complete the level faster than the low resolution test person. This is not possible to measure on a complete scale however, since a detour at the end of segment 2 causes different distance between the two environments. Readings from the first and third segment are however, still viable for validation of this hypothesis.

	high	low	t-test
Time to complete segment 1 - The streets	72,87	83,11	0,28
Time to complete segment 2 - The Alleys*	163,70	97,27	0,01
Time to complete segment 3 - The Chinese Quarter	118,91	116,03	0,44
Time to arraive at the factory*	282,61	213,30	0,04

Table 1: Time taken to complete the level under both conditions

Table 1 shows the results that were gathered objectively by the checkpoints which the test persons travelled through. Comparative statistics the relevant segments, 1 and 2, return no significant difference. Neither do the means give any indication that test subjects under one condition moves faster than the other.

Based on this data and the requirement set for its validation, hypotheses 1 cannot be confirmed from this test.

Table 2a: Information Catagorization

	High		Low		
	avrg	var	avrg	var	t-test
B02	3,16	1,62	2,68	1,31	0,07
B03	4,22	0,72	3,75	1,48	0,04
B04	4,34	0,65	4,19	0,84	0,24
B11	2,56	1,54	2,76	1,44	0,28
B19	2,61	1,42	2,85	1,58	0,24
B23	4,27	0,49	4,00	0,81	0,09
Total	3,52	1,07	3,37	1,24	0,37
StDev		1,15		1,54	

Table 2b: District Conceptualization

	High		Low		
	high	var	low	var	t-test
B10	2,91	1,78	2,94	1,31	0,46
B14	2,42	1,12	2,19	1,26	0,22
B15	3,10	1,97	2,66	1,39	0,10
B17	3,43	2,55	3,37	1,26	0,43
Total	2,97	1,86	2,79	1,31	0,30
StDev		3,44		1,70	

Table 2c: Landmarks

	High		Low		
	avrg	var	avrg	var	t-test
B06	2,52	2,53	2,37	1,69	0,35
B24	2,78	1,38	2,23	1,42	0,06
Total	2,65	1,95	2,30	1,56	0,09
StDev		3,81		2,42	

Table 2: Factors regarding the hypothesis of District Conceptualization

11.2.2 Results regarding hypothesis 2: District Conceptualization

The second hypothesis reads (see chapter 5.5.2 page 32): *"The player will in a process similar to Bordwells' narrative theory and create and maintain a mental model of space he is located in."*

Validation of this hypothesis will be based on the sub factors of pertaining to Information Categorization, District Conceptualization and Identification of landmarks, as described in chapter 10.3 (see page 56). Establishing a significant difference between the two test conditions where the high resolution environment provides a higher mean would validate this hypotheses.

As shown in Table 2, the test yielded no significant differences in any of the three factors that constituted the second hypothesis.

Questionnaire item B03 "*Did you recognize the doors as possible paths?*" yields a P value of 0,04, with an average mean of 4,22 in the high resolution environment and a variation of 0,72. The low resolution environment has a mean of 3,75 and a variation of 1,48.

Elaborative data, regarding which door was opened first, revealed that in the low resolution environment 15 of 31 test subjects chose the correct door first. In the high resolution environment 22 of 31 choose the correct door first.

Additionally the questionnaire contained a possibility for elaborating comments regarding item B24: "*How much did you notice special locations that you could use for navigation through the entire level?"* The question raised 44 observations in the high resolution environment and 26 in the Low resolution environment. Reports have been reproduced in Table 3.

Low resolution environment		High resolution environment	
Object	Reports	Object	Reports
LRC Sign	7	LRC sign	7
Location 1 (the plaza)	3	Location 1 (the Plaza)	4
Location 2	2	Location 2	1
Location 3	2	Location 3	1
Elevator/Lift	1	Elevator/Lift	5
Hotel	1	Hotel	1
Statue (samurai)	1	Statue	10
Additional comments in the low resolution environment: Switches (2 reports), Lights, Building Designs, Containers, Fence, Tunnel, Stairway. Two test subjects note that they used the LRC sign for navigational purposes (number 7 and 16)		Additional comments in the high resolution environment: "The Oven", "The wagon", Buildings, Broken Pipe, Chinese Gate, Buttons. "First doorway and elevator shafts" one subject describes "I tried the "least possible ways to go" first, to be sure I took the right passway afterwards"	

Table 3: Elaborating reports for question B24.

Based on this data and the set criteria for evaluation, hypotheses 2 cannot be validated from this test.

11.2.3 Results regarding hypothesis 3: Path Making

The third and final hypothesis is formulated as such: "*Based on this mental model of space, the player will actively plan routes through the environment.*"

As above, the hypothesis of path-making has been divided into two factors (see chapter 10.3 page 56). The validation of the hypotheses will be successful if a comparison yields a significant statistical difference with P value > 0,05 and a higher mean among the High Resolution test subjects. Additionally the third hypotheses presuppose the validation of the second hypotheses, as its functionality is dependent on the player's mental model of space.

Firstly the second hypotheses were not validated from the results of the testing. The questions posted towards the player's sense of direction did not yield a significant difference between the two environment, neither does the mean diverge enough to make assumptions in this regard. The factor of path-making didn't return a significant difference either.

Question B22: "*Are you currently confident you could make your way back to the hotel from the Factory?*" returned a P value of 0,02, which indicates a significant difference is to be found among the two test conditions. The average in the high resolution environment is 3,18 with a variance of 2,05 while the average of the low resolution environment is 3,80 with a variance of 1,13.

Table 3a: Sense of Direction

	High		Low		
	avrg	var	avrg	var	t-test
B08	3,46	1,22	3,29	1,33	0,25
B13	3,24	1,06	2,85	1,31	0,07
B18	2,56	1,89	2,56	1,84	0,09
Total	3,09	1,39	2,90	1,49	0,31
StDev		1,94		2,23	

Table 3b: Path making

	High		Low		
	avrg	var	avrg	var	t-test
B12	2,47	1,54	2,66	1,44	0,26
B20	2,03	1,84	2,26	1,23	0,24
B22	3,18	2,05	3,80	1,13	0,02
B25	2,90	0,97	2,90	1,18	0,14
Total	2,65	1,60	2,91	1,27	0,28
StDev		2,56		1,6	

Table 3: Factors regarding the hypothesis of Path making

The entire dataset from the test is included in Appendix E. In addition to this, the project CD contains all log files from the tests.

11.3 Preliminary Discussion

The results section informs that neither of the stated hypotheses can be verified from the prototype test. This section will look into the questions that did show a significant difference between the two test conditions. These items are:

- B03, that seeks to identify if the test subject regards doors as possible paths.
- B22, which ask if the player could perform a path-making process on demand.

This section will also investigate plausible error sources in the testing

- Lacking level of difference between the two environments

The sub-conclusion of this preliminary discussion should thereby inform the triangulating test, with regards to which areas will be of interest in the qualitative interview.

11.3.1 Indications from Item B03

Questionnaire item B03 deals with the categorization of doors as possible paths in the level as the only inquiry towards that specific element. Similar data objectively collected from the game environment shows that 15 of the 31, low resolution subjects attempted the correct door, before the other, whereas 22 of the 31 test subjects in the high resolution environment identified the correct door at first. This indicates very clearly, that the doors were recognized as a possible path, when the test subject arrived at the Plaza.

The difference here, between the high and low resolution environment were to add a gate outside the building that would actually lead the player forward. This is detailed in depth in chapter 9.2.3 (see page 47) and illustrated in Figure 22 and Figure 23 (see page 54).

Based on the empirical data gathered from the test, it can therefore be reasoned that a level of informational categorization is occurring for the player although not to the full extend that was described in the GRID model.

11.3.2 Indications from Item B22

A total of four questions address the player's active path-making process within the level, but no other question comes close to providing the same reading as item B22. This suggests that question B22 could actually be an error within the 5% probability that is left by the T-test.

Considering the formulation of the question; "*Are you currently confident you could make your way back to the hotel from the Factory?*", this is actually different from the other questions as it is formulated retro prospectively. In this regard the test subject is prompted to start a process of path-making, through bridging inferences performed on his knowledge of the level. In conclusion, the question does not ask if the player was making assumptions on paths while playing through the level, but instead, if he could make paths through the level.

For the questionnaire as a whole this is not a mistake, but a constructing component in the path making process, as such it provides little insight on its own.

11.3.3 Lacking difference between environments

The statistical data indicates clearly that either the theory supporting the GRID model and its organization in the model is incorrect to some degree, or there is not enough difference between the two test environments to measure the suggested factors.

A critical reexamination of the level indicates instances where there is not enough difference between the test conditions, for the test population to register this. These design flaws are as follows:

- B02: "How much did you use light and dark areas as part of your navigation?"
  Areas where the player is intended to go are usually lit, and in the instance of segment 2, color coded, as described in chapter 10.4.2 (see page 58). Correlating; paths that leads to dead ends have only very little light attached to them. Lighting could easily have had a more general implementation as informational cues for the test subject in the high resolution environment.
- B10 and B17 both ask towards the player's experience of thematic changes between the second and third segment. As with the usage of lights in the test environment, these conditions do not change between the high and low resolution environments.

The third stage of testing does provide the chance to investigate these items by asking questions in this regard during the interview.

11.3.4 Sub-conclusion

The lack of validation for the hypothesis generally allows for the interview to investigate the entire process of the GRID model. Further, questions should be asked towards path-making and the establishment of a mental model of space.

Besides re-iterating the main focus areas for the GRID model, special attention should be paid towards the navigational strategy of the test subjects. Reports from question item 24B indicate that some players may approach the navigational challenge differently (see Table 3 page 65).

11.4 Test procedure [Qualitative testing]

The aim of the qualitative test, were to further investigate the findings of the quantitative test. In this pursuit, the interview based test method provided the possibility for getting good results from a narrow audience. The downside to this kind of testing, is that with a small test population each test subject can sway the findings away from the actual results that the larger population would report. Because of this, the demographics were chosen from outside of the medialogy study as detailed in chapter 7.4.2(see page 43), to insure as much as possible, that the students were not bias regarding computer game studies.

The test setup during this stage of testing was the same as applied with the earlier test with minor adjustments.

- A video camera was placed in the corner of the room, to document the interview.
- The test supervisor, who would now interview the test subject, took a seat next to him as he was playing through the prototype.

The agenda for the qualitative testing elaborated on the quantitative testing by adding more elements to it. The test procedure was as follows:

- Introduction and briefing
- First prototype play-through
- Questionnaire
- Second prototype play-through under reverse conditions
- Interview

During this course of testing, every other test would play with the high resolution test conditions first, then answer the questionnaire and then play under the alternative conditions. Answers provided in the report were of no actual consequence to the evaluation of the test in this stage of testing, but the questionnaire was still applied, to foster a player perspective that could lead to an interesting interview.

The second time the test subjects played through the prototype; they were encouraged to speak their thoughts, impressions and considerations out loud. If a test subject reported anything of interest to the report, this would be taken up during the interview.

11.5 Qualitative Results

Four test subjects participated in the qualitative test. All were students connected to IHK except one, who studied physics at the University of Copenhagen. Each of the tests lasted roughly an hour.[14]

11.5.1 Test Subject C01: Henrik Bartle

Henrik Bartle started playing through the prototype under the low resolution test environment. He seemed very secure with the interface and did not have any trouble completing the level. In the following interview Henrik reported the following:

- In the low resolution environment, the test subject noticed the LRC sign, but did not in the second as his attention was caught by the statue in the center of the Plaza.

---

[14] Video recordings of the test are available on the report CD, except test c02, which was not recorded due to the tape running out.

- The test subject noted that he felt a thematic change when he entered the second segment of the level where the corridors narrowed in. He also registered a change when he entered the fog in the Chinese quarter.
- The test subject could not identify with having a mental understanding of the game space.
- When verbally asked if he could make his way back from the factory to the hotel, the test subject began giving directions and added to these, series of hand movements where he was showing the interrelationships between objects.

11.5.2 Test subject C02: Tim Magnusson

This test was conducted with the low resolution environment first and the high resolution environment last.

- The test subject was confused around the second segment, and started to backtrack to his earlier location. After a short while, he found his way through the second segment and completed the course.
- The test subject evaluated the world as static and was actively looking for signs of living agents.
- In the interview the test subject explained that he was looking for some sort of validation at a prior location, before he would continue forward.
- When asked about a mental image of the game space, the test subject responded that he may have an understanding of the space, after the second time through the level.
- The test subjects explained that he recognized scripted elements in the level, as signs of progress.

11.5.3 Test subject C03: Jonhard

This test was conducted with the high resolution environment first. The test subject showed no signs of trouble with the interface, but was clearly not as experienced in the game genre as other test subjects had been.

- During the interview, the test person admitted that he had been looking for “Pick ups” around the level. This would be points or maybe weapons and ammunition that he could use if he came into conflict.
- When asked about path-making or landmarks, the test subject declined without elaboration.
- The test subject took note of the fog in the Chinese Quarter, suspecting it would perhaps signal some kind of danger ahead.

11.5.4 Test subject C04: Henrik Jørgensen

The final test subject started with the high resolution environment. He did not exhibit any noteworthy traits while playing the game, but provided a good narration of his considerations.

- The test subject noticed the doors as a possible path on first approach, but chose to investigate the streets first instead. The test subject identifies the doors with one being light (supposedly the door with the gate, that leads forward) and the other being dark.
- In the plaza, the test subject noticed the LRC sign.
- The test subject identified the alley as “another factory” which he had to pass through in order to get to his goal.
- When asked if he was sustaining a mental representation of the level he had just played through, the test subject didn’t seem to understand and answered that he did not.
- The test subject reports that there little difference between the two environments.

11.6 Final discussion

The information provided through the interviews points towards a number of observations that should be considered in regards to the validity of the GRID model.

11.6.1 Mental Model of Space

The notion of a mental model may be over estimated, as indicated from the interviews where none of the subjects identified with it. This can be explained by the two different inference strategies that were discussed in the pre-analysis chapter 3.1.1. In a situation where the player makes Constructiuvistic inferences on his environment, he will elaborate on the information given and thereby construct a mental model of space. This is the same method David Bordwell's Viewer applies when following the action of a film (see chapter 3.3.2) as well as the process that the GRID model is constructed upon.

Playing through a level is not always something that requires an elaborate understanding of the surroundings. Returning again to *Super Mario Bros.* [Nintendo, 1985] and the established concept of the linear level, provides evidence that some games include few requirements for navigation. Although this is not necessarily true for the action/adventure genre, it may be a preconception for the player which he will act upon until the game forces him into a navigational challenge. At this point, the player may begin making elaborative inferences.

This perspective towards the players understanding of the level, thereby suggests that the inferences drawn upon the environment are approaching, if not fully, minimalistic (also in chapter 3.1.1) in which case, the player would only draw the bridging inferences that provide coherency in the game, and those inferences which are quick and easy.

11.6.2 Path making

As have been reported from the qualitative interviews, some test subjects plan paths through the environment. Where this thesis has initially presupposed that the process of path-making were depend on the players mental model of space (see Hypothese 3 in chapter 5.5.3 as well as chapter 6.4.1) this may not be the case.

Path-making may be a process that occurs in goal-oriented situations, contrary to being a constant process. To investigate this further, a crude cut was made between subjects in the entire test population where all test participants who did not notice the LRC sign was removed from the results sheet. This was done by excluding all participants with a rating of less than 4 in question B05 "*Did you notice how it was possible to observe a later part of the level (the factory) and use that to navigate afterwards?*"

The remaining test population can only provide assumptions towards the hypothesis since the population was limited to 13 subjects under the high condition and 15 in the low condition. A combination of these test subjects reveals high averages regarding the following questions:

- A06 How compelling did you feel it was to move around the environment: 4,07 (mean) 0,64 (variance)
- B03 Did you recognize doors as possible paths: 4,00 (mean) 1,00 (variance)
- B04 Did you recognize roads as possible paths: 4,36 (mean) 0,66 (variance)

These numbers indicate of a population that was very engaged in the path-finding exercise and as such, suggests that once the player is aware of the goal as his ultimate location, the categorization of elements that will lead him there become more important to his perception of the level.

12 Conclusion

The final chapter concludes on the findings of the test and provides a perspective on how further research within this framework could be pursued.

Most important for this thesis, is the fact that none of the hypothesis was verified during the testing. As stated in the preliminary test discussion (chapter 11.3) this may be caused by lacking difference between the two test environments.

Another reason why the test does not validate the hypothesis, were given in the final discussion chapter 11.6, that the GRID model presupposes that the players of a computer game are making elaborative inferences as constructivist cognitive psychology suggests they do. Elaborative inferences, which are inherent to both sense-making in story-comprehension of narrative film theory, and a necessity for path making in urban environments, may not be applied to computer games. The functionality of levels, are that they form directed maps, which the player must decode, but elaboration serves no purpose, since the game will eventually reveal its own path.

While neither of these can be verified, an interesting observation from the test data is given in the final discussion, where players which have seen their end destination early on, were more confident in their identification of paths that would get them there. The same test persons also reported the prototype very compelling.

12.1 Future Work

Observations from the test, indicates strongly established conventions within genre. In the first iteration of the product especially, the doors were seen as non-interactive. Film theory applies the notion of inter-textual references, as cues that motivates the usage of already established knowledge to the current experience, in some cases through specific other films (such as sequels or parodies), and other times through genre conventions. This is also true in the medium of computer games, but here the lesson learned above, indicates that genre conventions in computer games are a determinant of which items are interactive.

This information indicates that interactive environments are intra-textual, in the sense that the player must learn which interactive options he is being afforded by the game. A further study of how cognitive learning processes functions within genres could be motivated through these observations.

Appendix A: Bibliography

1. Csikszentmihalyi, Mihaly. Flow: The Psychology of Optimal Experience. New York : HarperCollins, 1991.

2. Games Telling Stories? -A brief note on games and narratives. Juul, Jesper. 01, s.l. : Game Studies, 2001, Vol. 01.

3. Salen, Katie and Zimmerman, Eric. Rules of Play: Game Design Fundementals. Cambridge, Massachusetts and London, England : The MIT press, 2004.

4. Ryan, Marie-Laure. Narrative as Virtual Reality. Baltimore and London : John Hopkins Univerisity Press, 2001. 0-8018-7753-9.

5. Murray, Janet H. Hamlet on the Holodeck, the future of Narrative in Cyberspace. Cambrige, Massachusetts : MIT press, 1997.

6. al., Bjørkå et. Saint Sophia's. Copenhagen : Aalborg University, 2007.

7. Game Design as Narrative Architecture, in First Person. Jenkins, Henry. Cambridge, Massachusettes and London, England : MIT Press, 2004.

8. Co, Phil. Level design for games. creating compelling game experiences. Berkeley : New Riders Press, 2006. 0-321-37597-1.

9. Rollings, Andrew and Addams, Ernest. On Game Design. s.l. : New Riders Press, 2003.

10. Towards an Ontological Language for Game. Zagal, José P, et al. 2005, Georgia Institute of Technology : DiGRA.

11. Keane, Mark T and Michael, Eysenck W. Cognitive Psychology: A student's Guide (fifth edition). East Sussex : Psychology Press, 2005.

12. Matlin, Hugh J and Foley, Margaret W. Sensations and Perceptions, fourth edition. Boston, London, Toronto, Sydney, Tokyo, Singapore : Allyn and Bacon, 1983.

13. Categorization of Affordances. Zhang, Jiajie. Huston : University of Texas, 2006, Vol. Cognition & Pragmatics.

14. Schemata Theory: An Introduction. Widmayer, Sharon Alayne. George Mason University : s.n. [URL] http://www2.yk.psu.edu/~jlg18/506/SchemaTheory.pdf.

15. Wayfinding Choremes - Conceptualizing Wayfinding and Route Direction Elements. Klippel, Alexander. Bremen: Universität Bremen, 2003 : SFB/TR 8 Monographs, 2003, Vol. 1. ISBN 3-88722-590-2.

16. Introduction to Game Time, in First Person. Juul, Jesper. Cambridge, Massachusettes and London, England : MIT press, 2004.

17. Field, Syd. Screenplay - The Foundations of Screenwriting. New York : Bantam Dell, 2005.

18. Bordwell, David. Narratives in Cinema. s.l. : New Riders Press, 1998.

19. Felluga, Dino. Introduction to Narratology. "Modules on Brooks: On Plotting." Introductory Guide to Critical Theory. [Online] July 17, 2002. [Cited: 12 12, 2007.] http://www.cla.purdue.edu/english/theory/narratology/ (two seperate pages included as PDF on the project CD).

20. Thompson, Kirstin and Bordwell, David. Film Art - an introduction (seventh edition). s.l. : Mc Graw Hill, 2004.

21. Lynch, Kevin. Image of the City. Massachusetts : MIT press, 1960.

22. (Author), Homer and Lattimore, Richard (Translator). The Odyssey of Homer . New York : HarperCollins, 1999.

23. Environmental Storytelling: Creating Immersive 3D Worlds Using Lessons Learned from the Theme Park Industry. Carson, Don. s.l. : Gamasutra, March 01, 2000.

24. Verne, Jules. Journey to the Center of the Earth. s.l. : Pinguin Books, 1965.

25. Kavakov, Ilya and Emilia. Ilya and Emilia Kavakov. [Online] StudioSonic Interactive Media, 2001. [Cited: 12 13, 2007.] http://www.ilya-emilia-kabakov.com/.

26. Measuring , Presence in Virtual Environments: A Presence Questionnaire. J., Witmer B. G. and Singer M. 3, U.S. Army Research Institute for the Behavioural and Social Sciences : MIT Press, Cambrige, MA, 1998, Vol. 7.

27. Bjørkå, Henrik. Indexical feedback and player-avatar agency Conventional HUD feedback vs. Indexical Feedback. Copenhagen : Aalborg University, 2008.

28. Manovich, Lev. Navigable Space. Lev Manovich. [Online] [Cited: 12 13, 2007.] http://www.crac.org/htmls/levspace.html.

29. Educational Feature: A History and Analysis of Level Design in 3D Computer Games. Shahrani, Sam. http://gamasutra.com/features/20060425/shahrani_01.shtml, s.l. : Gamasutra, April 25, 2006.

30.

31. Measuring Presence in Virtual Environments: A Presence Questionnaire. Witmer, Bob G and Singer, Michael J. 3, Massachusetts : Massachusetts Institute of Technology, Presence , 1998, Vol. 7.

Appendix B: Ludography

The following section lists the games referenced in the report. The director is included where possible but the author of this report recognizes that game development is a team effort.

Descent
Parallax Software, 1995

Diablo
Blizzard North, 1996

Doom
John Romero, ID software, 1993

Grand Theft Auto
Rockstar Games, 2001

Half-Life 2
Valve Corporation, 2004

Halo: Combat Evloved
Bungie Software, 2001

Harry Potter and the Chamber of Secrets
EA games and Warner Bros. Interactive, 2002

Hitman: Codename 47
IO interactive, 2000

Pacman
Midway and Namco, 1980

Resident Evil II
Hideki Kamiya
Capcom, 1998

Sid Meyer's Civilization
Sid Meyer
Microprose, 1991

Silent Hill
Konami/Team Silent, 1999

Silent Hill 2
Konami/Team Silent, 2002

Silent Hill 4: The Room
Akria Yamaoka
Knoami/Team Silent, 2004

Sim City
Will Wright
Maxis, 1989

Super Mario World
Shigeru Miyamoto
Nintendo, 1990

Super Mario Bros.
Shigeru Miyamoto
Nintendo, 1985

Space Invaders
Tomohiro Nishikado
Midway, 1987

Tetris
(Various distributers)
Alexey Pajtnov, 1985

Total Overdose
Deadline Games, 2005

Unreal Tournament
GT interactive, 1999

Appendix C: Keywords

The following list of keywords references concepts that may be useful for the reader. References to specific games are included in *italic*.

Appendix D: Works of Ilya Kabakov

The Man Who Flew Into Space from His Apartment (1), 1968

The Man Who Flew Into Space from His Apartment (2), 1968

Appendix E: Test results

The following data is copied from “test results.xlsx” provided on the CD. All test logs are also included on the CD.

		High Resolution		Low Resolution		
		Mean	Varience	Mean	Varience	T-test
Demograpichs						
A01	Your age	23,71	13,67	22,88	6,69	
A02	Current Occupation					
A03	How many hours do you spend playing computer games a week?	2,97	1,15	3,07	1,48	
A04	On the folloiwng computer game genre, choose the 3 you like the best at rate them in oder from 1-3, where '1' identifies the genre you like the most.					
	Sandbox	2,40	0,24	3,00	0,00	
	Strategy	2,13	0,69	2,17	0,39	
	Action	2,00	0,83	1,80	0,69	
	Role-playing	1,57	0,53	1,65	0,66	
	Adventure	2,19	0,65	2,08	0,69	
	Sports Games	2,63	0,23	2,14	0,41	
	Vehicle Sim	2,00	1,00	1,88	0,61	
	Puzzle	1,80	0,56	2,29	0,78	
	Other	1,50	0,75	2,80	0,16	
A05		3,73	0,93	3,88	1,08	
General Game Experiences						
A06	How compelling did you feel it was to move around inside the game environment?	3,90	0,58	3,78	0,56	0,25
A07	Where you aware of events occuring in the real world around you, during the game?	2,22	1,49	2,27	1,27	0,48
A08	Did you notice the numbers occuring in the left side of the screen during the game?	1,20	0,30	3,98	1,73	0,00
A09	Rate how much these factors had your focus in the test.					
A09 - a	Avoiding harmful elements	3,71	1,48	3,73	1,42	0,36
A09 - b	Navigating the environment	4,12	0,74	4,15	0,76	0,42
A09 - c	Exploring the environment	3,61	1,12	3,32	1,88	0,22
A09 - d	Finishing the test	3,76	1,26	3,73	1,42	0,48

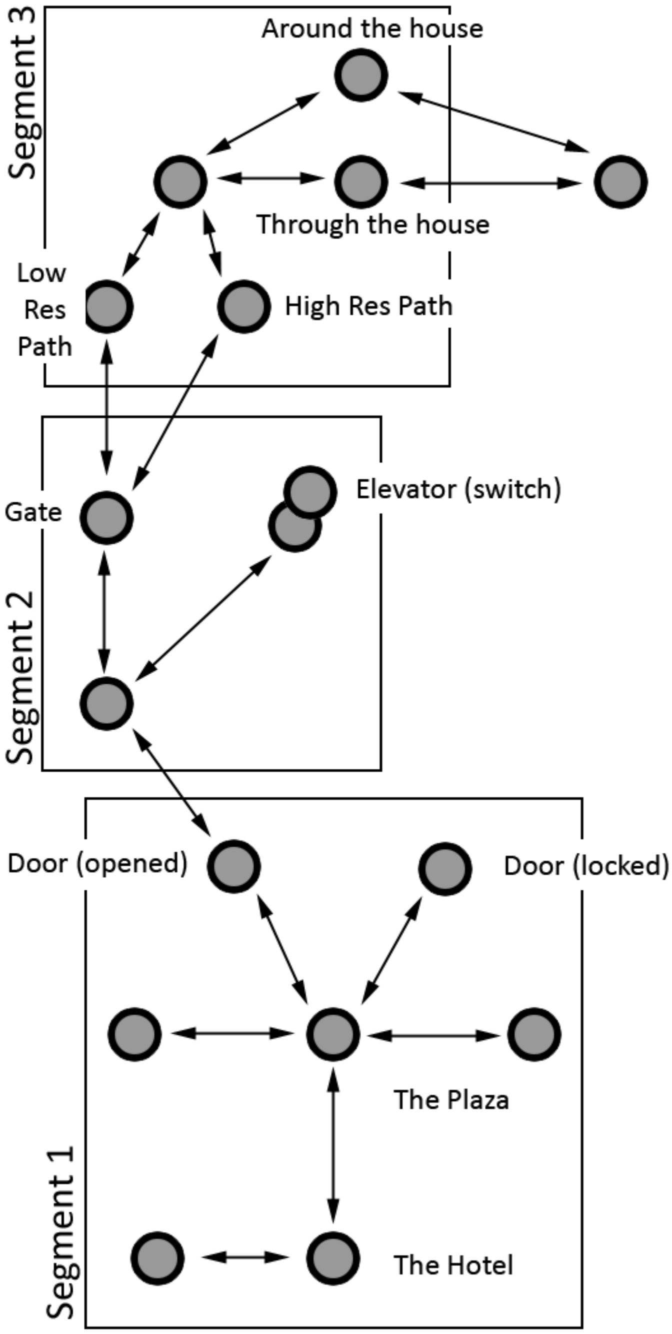
			High Resolution		Low Resolution		
			Mean	Varience	Mean	Varience	T-test
Spatial Navigation							
Location 1		Factors					
B01	How well do you recall this location?	CL	4,17	1,07	3,08	1,97	0,00
B02	How much did you use light and dark areas as part of your navigation?	IC	3,03	1,62	2,62	1,31	0,13
B03	Did you recognize the doors as possible paths?	IC	4,10	0,72	3,71	1,48	0,06
B04	Did you recognize the roads as possible paths?	IC	4,29	0,65	4,29	0,84	0,42
B05	Did you notice how it was possible to observe a later part of the level (the factory) and use that to navigate afterwards?	PM	2,76	2,56	2,85	2,54	0,37
B06	Did you identify the ‘plaza’ as a specific location?	L	2,60	2,53	2,32	1,69	0,19
B07	To what extend did you observe possible paths which you did not take?	PM	3,00	1,20	2,92	0,97	0,50
B08	To what extend did you feel confident that you were going the right way?	SoD	3,46	1,22	3,29	1,33	0,29
Location 2							
B09	How well do you recall this location?	CL	3,15	1,28	3,61	1,07	0,03
B10	Do you recall recognizing a thematic change in the environment?	DC	2,78	1,78	2,95	1,31	0,30
B11	Did different colors of light help you navigate through this part of the level?	IC	2,47	1,54	2,66	1,44	0,36
B12	How much did you experience being on a detour?	PM	3,03	1,36	3,00	1,64	0,39
B13	Passing through this area confused you, regarding sense of direction?	SoD	3,24	1,06	2,85	1,31	0,06
B14	This location uses very narrow paths, how much did this affect you?	DC	2,30	1,12	2,36	1,26	0,40
B15	This location introduces lifts, which takes you high above ground. How much did this affect you?	DC	3,03	1,97	2,58	1,39	0,08
Location 3							
B16	How well do you recall this location?	CL	3,13	2,36	3,38	2,43	0,19
B17	Do you recall recognizing a thematic change in the environment?	DC	3,26	2,55	3,32	2,60	0,45
B18	Passing through this area, did your sense of direction increase?	SoD	2,56	1,89	3,03	1,84	0,08
B19	Location 3 is build around a fairly simple notion of a “courtyard” while playing, to what extend did you recognize it as such?	IC	2,47	1,42	2,76	1,58	0,16
B20	How confident are you, that you could take a shortcut to this area from the hotel, in a larger implementation?	PM	2,03	1,84	2,26	1,23	0,25
The outdoor Game world							
B21	How much did you feel guided (or forced) while playing the level?		2,82	0,92	2,95	1,36	0,32
B22	Are you currently confident you could make your way back to the hotel from the Factory?	PM	3,18	2,05	3,80	1,13	0,02
B23	Did the objects in the world seem natural to your understanding of the world?	IC	4,23	0,49	3,85	0,81	0,01
B24	How much did you notice special locations that you could use for navigation through the entire level?	L	2,69	1,38	2,44	1,42	0,20
B25	To what extend did you feel lost while playing through the level?		2,90	0,97	2,65	1,18	0,15

CL: Confidence Level, IC: Information Catagorization, DC: District Conceptualization. L: Landmark Identification. SoD: Sense of direction. PM: Path-making.

		High Resolution		Low Resolution		
		Mean	Varience	Mean	Varience	T-test
	Time of completion					
	Segment A	71,95	4012,53	94,89	6388,12	0,08
	Segment B	244,13	30304,75	199,71	13889,76	0,09
	Time to complete segment B	172,19	18570,77	104,82	7365,66	0,01
	Segment C	289,08	33691,92	233,39	14499,33	0,06
	Time to complete segment C	116,90	5301,60	128,57	6482,62	0,25
Elaborative Data						
	The player choose check point A06 before A05 (true or false)	0,66	0,22	0,55	0,25	0,16

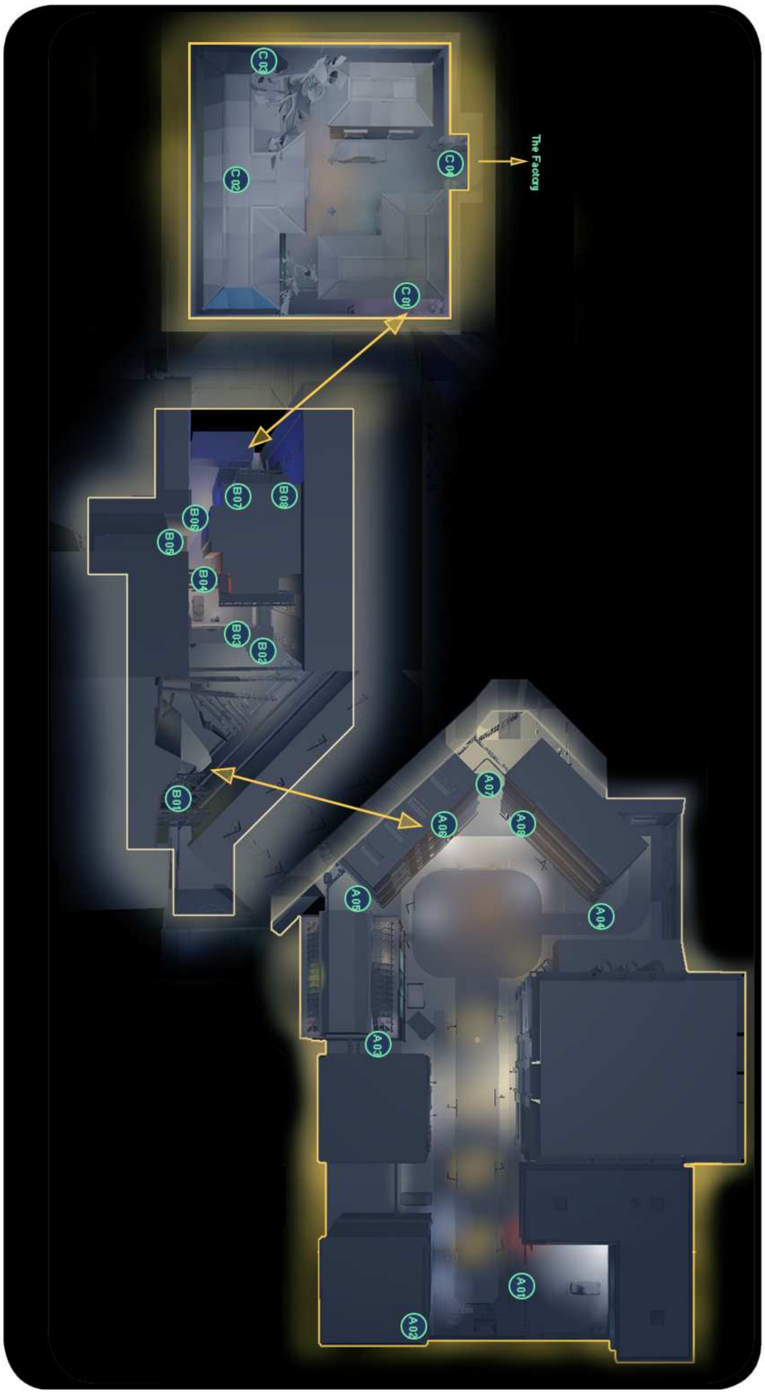
Appendix F: Implementation graph

The following figure describes the relationship between the key events that are detailed in the design specification.



Appendix G: Checkpoints in the Prototype

A total of 18 checkpoints monitored the progress and choices of the test persons. The internal timer that registered whenever the player crossed into a checkpoint was initially set as the player left the hotel crossing checkpoint A01.



Appendix H: Questionnaire

Questionnaire page 1

Questionnaire page 2

Questionnaire page 3

Appendix I: Material handouts

What follows is the printed material that was provided along with the test. The text on the mission briefing reads:

Mission Briefing Hello, and thanks for participating in our joint testing. Soon you will be let loose in our prototype; here your purpose will be to locate the escape vehicle (left) that is located on top of the LRC factory building (below). Along the way, we kindly ask you to be mindful of the playing experience. Before you begin, we ask that you make sure your test supervisor has set your test ID. The test beings when you leave the hotel. Thanks and good luck, Henrik and Lucas

Illustration 8: Mission briefing (located on the wall between the two test machines)

Illustration 9: Location 1 as viewed in the high resolution environment

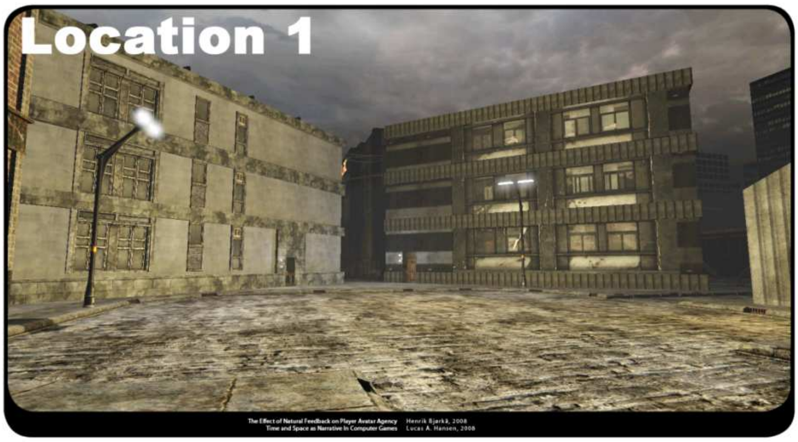


Illustration 10: Location 1, as viewed in the low resolution environment

Illustration 11: Location 2, as viewed in the high resolution environment

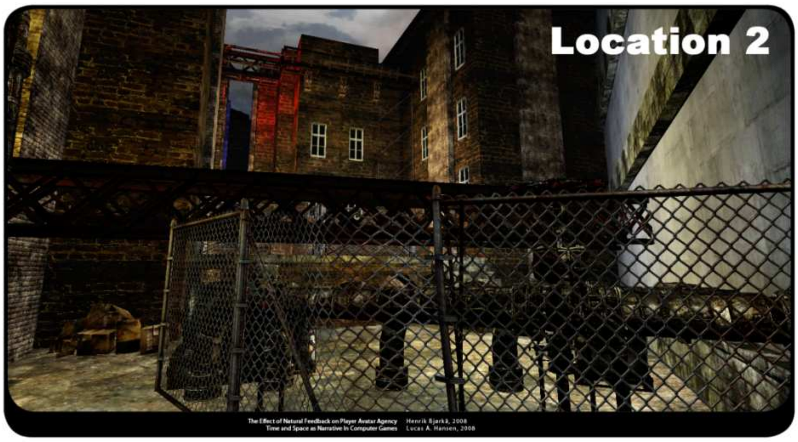


Illustration 12: Location 2, as viewed in the low resolution environment

Illustration 13: Location 3, as viewed in the high resolution environment

Illustration 14: Location 3, as viewed in the low resolution environment